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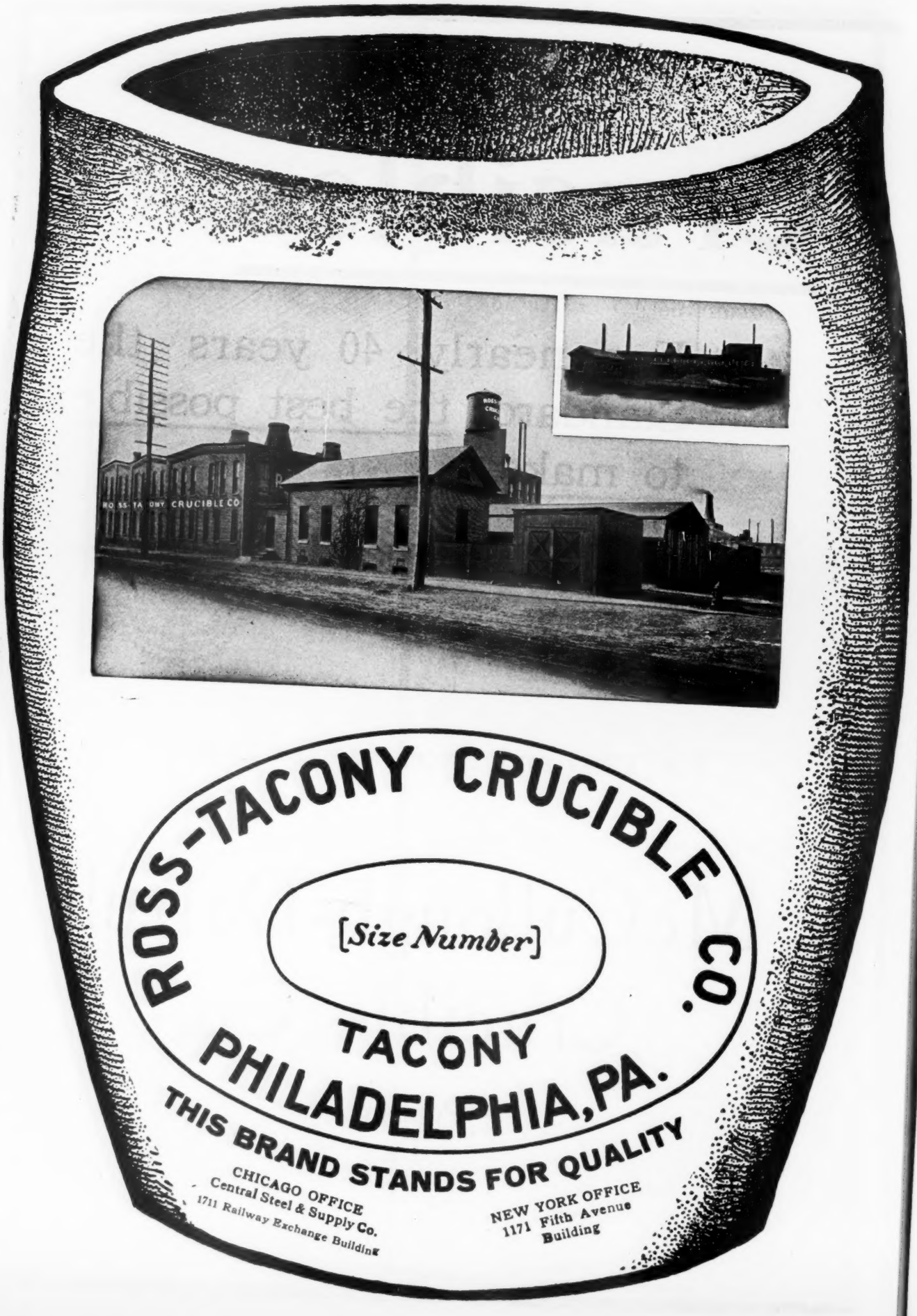
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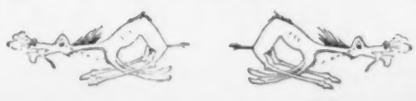

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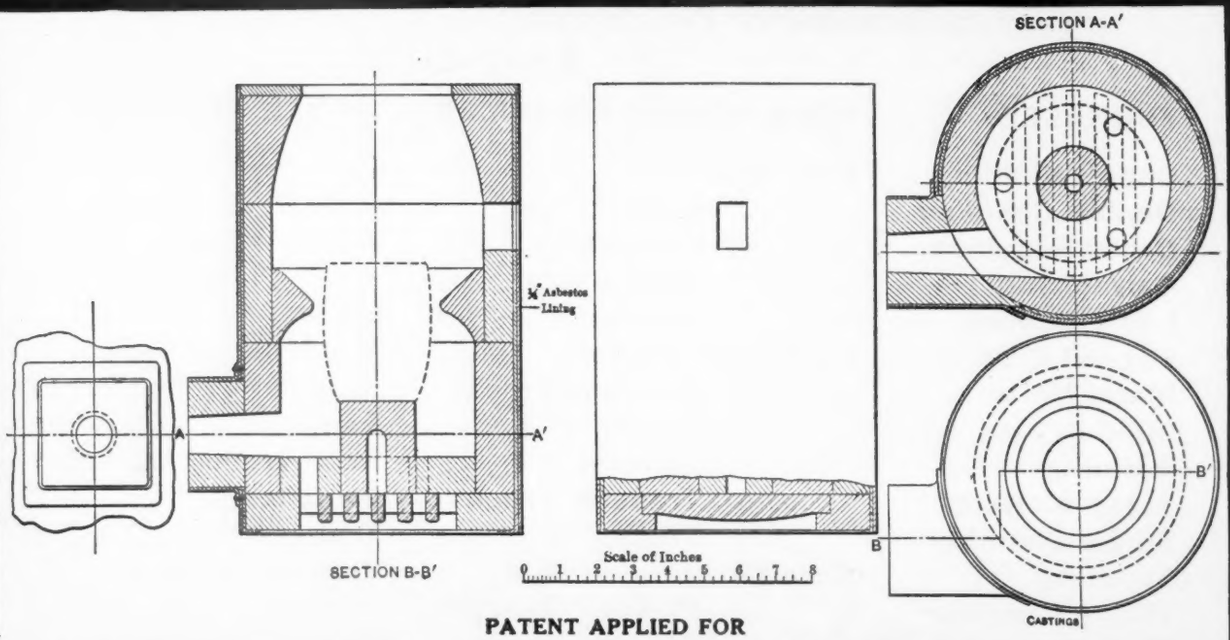

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THE FOUNDRY

Vol. 37, No. 4 Cleveland, Ohio, December, 1910 Whole No. 220

USE OF VANADIUM IN STEEL CASTINGS

And the method of molding and casting locomotive main frames at the plant of the Union Steel Casting Co.

STEEL castings are now being so extensively used that one is apt to overlook the great advances that have been made in this branch of the founder's art in recent years. It seems quite natural to expect as good results with steel as with any other metal. However, only a few years ago a steel casting was quite a curiosity, and it would never have been considered possible to cast such intricate shapes as are being made today. Some interesting examples of what can now be accomplished are furnished by the various types of castings made by the Union Steel Casting Co., Pittsburg.

This concern, which has made extensive experiments with vanadium in steel, was the first to take up this subject, and with such success, that castings of this metal now form a large proportion of its output. One of its specialties is locomotive main frames, both of vanadium and carbon steel, and several floors are kept running steadily on this work, one railroad alone, in the last two years, having required 90 pairs of these castings of vanadium steel. The average weight of locomotive main frames is from 8,000 to 9,000 pounds, according to the length, which varies from 30 to 36 feet, and the amount of metal required to fill the molds is about 13,000 pounds.

Fig. 1 shows a portion of the molding floors, where the frames are made. The open mold in the foreground, *B*, was photographed just after the pattern was drawn, and it will be noted that it is one of the shorter frames, as it does not extend the full length of the flask. At the ends of the molds several of the patterns are shown stacked up. It will be observed that they are in two pieces, which makes them better to handle, easier to draw from the sand, and reduces the tendency to warp.

The flasks for these frames are built up of short, flanged steel plates, bolted together, their construction being plainly shown in Fig. 1. The molding of main

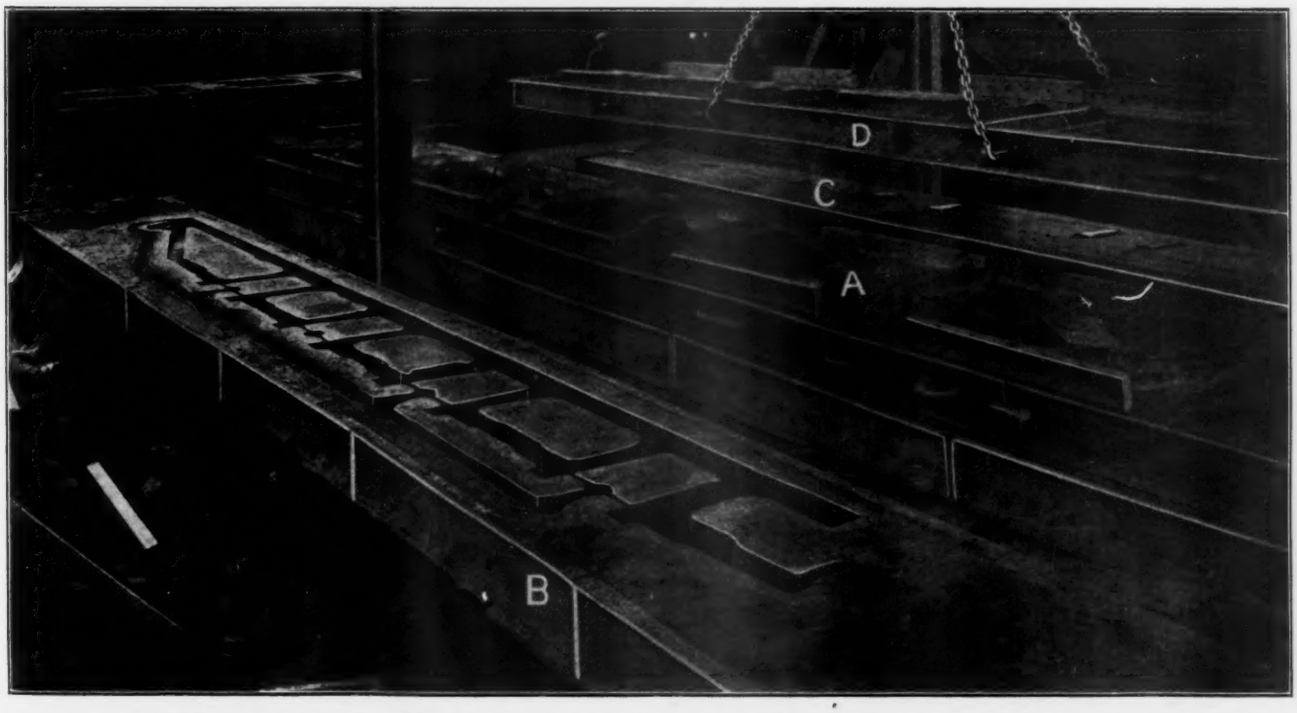


FIG. 1—MOLDS FOR LOCOMOTIVE MAIN FRAMES IN THE FOUNDRY OF THE UNION STEEL CASTING CO., PITTSBURG

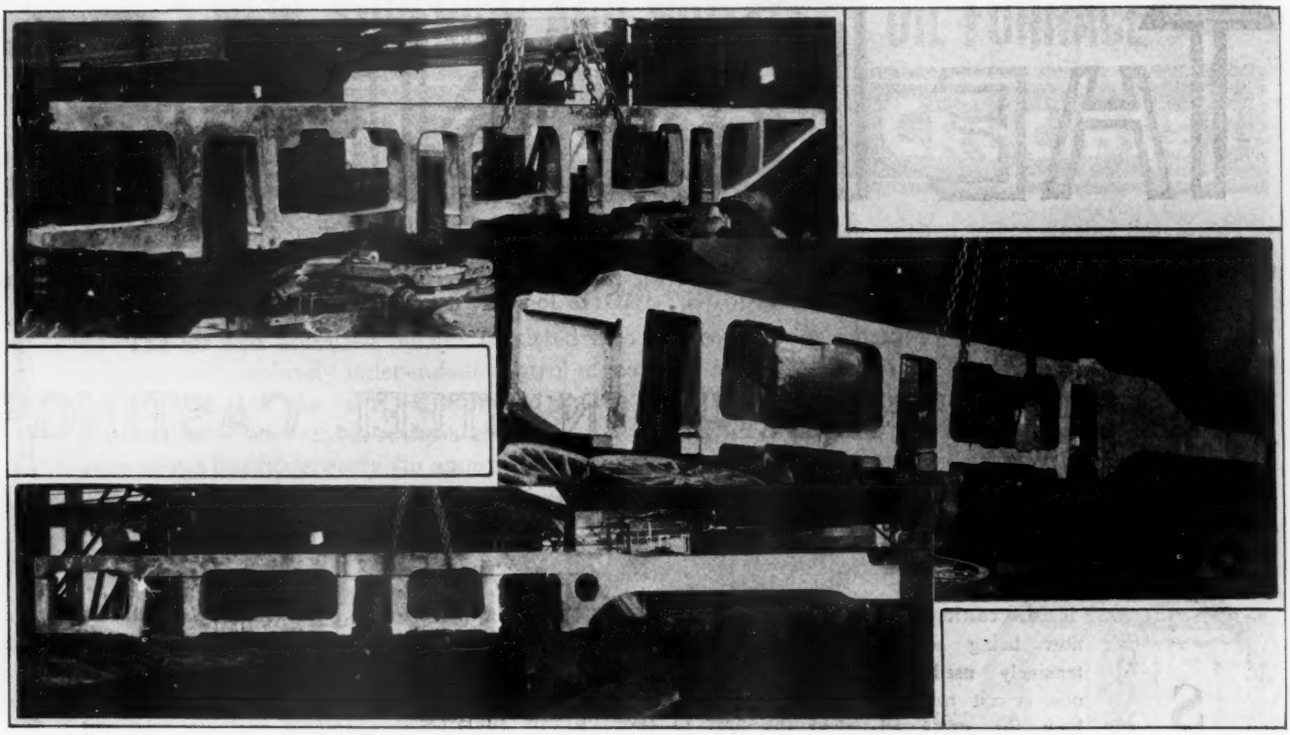


FIG. 2—CARBON STEEL LOCOMOTIVE MAIN FRAME FIG. 3—CARBON STEEL MAIN FRAME FOR ELECTRIC LOCOMOTIVE
FIG. 4—VANADIUM STEEL MAIN FRAME FOR CONSOLIDATED TYPE LOCOMOTIVE

frames is not a difficult operation, as the pattern is simple and entirely in the drag, the cope being plain and flat. Therefore, the pattern can be bedded-in conveniently, and the drags thus always retain their position on the floor. When a casting has been removed, dry sand is shoveled out and tempered sand rammed in as required; then the pattern is bedded and rammed up flush with the joint of the drag, and the parting made. A mold at this stage is shown at *C*, Fig. 1, with the empty cope, *D*, suspended above it.

Fig. 2 shows a main frame of carbon steel, made for class K-2, Pacific type, locomotives, for the Pennsylvania Railroad Co. It is shown suspended from the crane in the cleaning shop, with all gates and risers removed. Fig. 3 is another type of frame, intended for the Pennsylvania railroad's new electric locomotives, while Fig. 4 is a vanadium steel main frame for the Delaware, Lackawanna & Western consolidated locomotives, which were built at the Schenectady works of the American Locomotive Co.

Physical and Chemical Properties.

The minimum tensile strength allowed on these castings is 60,000 pounds per square inch on carbon steel, but it is rarely that they fall below 70,000 pounds, with 27 to 28 per cent elongation, 37,000 to 39,000 pounds elastic limit and 40 per cent reduction of area. The chemical analysis is approximately as follows:

	Per cent.
Silicon	0.25 to 0.30
Sulphur	0.04 maximum
Phosphorus	0.05
Manganese	0.55 to 0.65
Carbon	0.26 to 0.30

Vanadium steel contains about two-tenths of 1 per cent of vanadium, which has the effect of greatly increasing the tensile strength and elastic limit. Castings of vanadium steel have been made by this company, the tensile strength of which reached 90,000 pounds per square inch, but the average tensile strength is 80,975 pounds, with an elastic limit of 45,024 pounds.

FIG. 5—CAST STEEL PLUNGER BARREL AND BASE, FOR A 15,000-GALLON PUMP

Problems Incident to Casting Steel.

A large percentage of the problems incident to the casting of steel had its origin in the refractory nature of the material, which made it necessary to obtain higher temperatures than had ever been attempted before. After the furnaces to produce these temperatures were perfected, it required years of study and experiment to master the details involved in their successful operation, not only to liquify the metal so that it would flow and properly fill the molds, but to produce steel of definite composition.

The two open-hearth furnaces operated by this concern are of different types, one being a Swindell and the other a Laughlin, which are operated up to their capacity. The additions of ferro-silicon and ferro-manganese are made to the bath in the furnace while the metal is being poured, small additions of aluminum being tossed into the heads.

Intricate Castings.

An extensive jobbing business is also carried on, and some very large and difficult castings have been produced. A remarkable example of steel foundry work is shown in Fig. 5, which is cast steel plunger barrel and base, the latter being cast separately, and weighed 7,315 pounds. The weight of the large

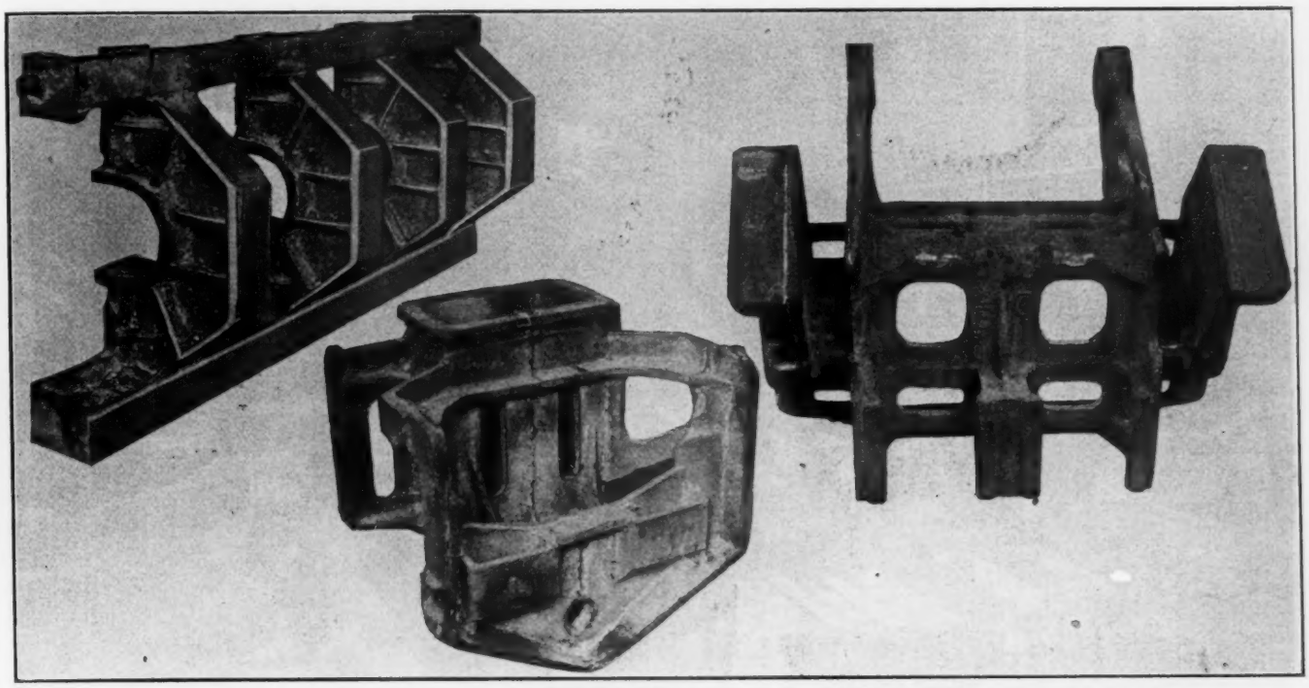


FIG. 6—CAST STEEL MARINE ENGINE BED PLATE

FIG. 7—DRAFT GEAR CASTING FOR AN ELECTRIC LOCOMOTIVE

FIG. 8—STEEL JACK SHAFT BEARING FOR AN ELECTRIC LOCOMOTIVE

body, or barrel, was 22,865 pounds. The illustration shows the casting cleaned, with gates and risers removed. Another large casting is shown in Fig. 9, which is a double discharge valve chamber for a 9½-inch hydraulic pump, weighing 4,200 pounds. This is also a good example of the progress made in casting steel, with its two heavy chambers and the comparatively light connecting portion in the center. Fig. 7 is a draft gear casting, and Fig. 8 is a steel jack shaft bearing for electric locomotives. These two shapes were quite difficult to mold, requiring considerable core work. On the casting, Fig. 8, there are heavy and light sections, weakly tied together at one end, with cores between—just the kind of a shape to cause great trouble by cracking—so that it will be apparent that the cores had to be made very soft and yielding.

Another type of vanadium steel casting is the marine engine bed plate, shown in Fig. 6.

In addition to the locomotive main frames, a large number of driving wheels, cylinder heads, rocker arms and other locomotive castings are made. Fig. 10 is a view of one portion of the shop, and shows the floor filled with the smaller molds in various stages of completion. In the foreground is a mold ready for the cope to be rammed, and the manner in which it is gaggered shows how thoroughly the sand is secured, to guard against the possibilities of a drop-out.

The process of packing sand around patterns is essentially the same in making molds for all metals, and in the case of iron and brass, suitable sands are found in a natural state, which require little preparation to be used for molding purposes. These natural sands are not sufficiently refractory for steel, as they fuse, producing dirty and pitted castings, so that it became necessary to find some material that would withstand the heat. This was found in silica sand, but it would not pack together to form molds, consequently it was necessary to mix it with clay and other substances, to give it an artificial bond, so that it could be used with the same facility in molding as the natural sands. This was one of the problems which early confronted the steel founder, and much of the success of the Union Steel Casting Co. in making difficult castings is due to the excellent mixture of silica facing it has developed. This is due to the high percentage of silica, 97.4 per cent, which enables it to withstand the intense heat without fusion, so that it peels and leaves the casting with a nice clean skin.

The smaller molds are dried in an oven with natural gas, as they can be easily handled by the cranes. They are

FIG. 9—CAST STEEL, DOUBLE DISCHARGE VALVE CHAMBER FOR A LARGE HYDRAULIC PUMP

FIG. 10—GENERAL VIEW OF THE MOLDING FLOOR OF THE UNION STEEL CASTING CO.'S FOUNDRY

faced with the silica facing, and the sand piles shown contain heap sand, which is used for backing purposes, as is usual in molding for steel.

Making Clay Crucibles

CRUCIBLES used for melting steel in Sheffield, Eng., were formerly made by the consumer and their manufacture formed an important part of the steel-making process. The first step consisted of mixing varying proportions of different clays together in a dry state, with small additions of coke dust and burnt clay. After mixing thoroughly the mass rendered plastic by water, was kneaded by being trodden with the bare feet to drive out the air and to thoroughly incorporate the mass. The clay was next cut into pieces, each sufficient to form a crucible, the pieces being weighed to insure uniformity. The next operation was to work each piece into a ball by throwing and rolling it on a bench for several minutes. These balls were made into crucibles in a mold with a loose bottom, which had a hole in the center to locate the plug or shape which formed the inside of the pot, and which was provided with a pin on the bottom to engage in the hole in the mold bottom. In making the crucibles, the mold was well oiled and a ball of clay dropped in; the plug was forced through the clay by working it up and down until the pin had entered the guide hole. This forced the clay half way up the walls of the mold, and at this stage the plug was hammered into position, forcing the clay to the top of the mold, after which it was leveled. The plug was next removed, leaving the new crucible in its mold. This was then set on a post, the mold being stripped off, leaving the pot setting on the loose bottom.

Finishing the Pot.

The next operation consisted of making the mouth of the pot, giving it the regulation crucible shape, as up to this point, it had a diminishing taper downward, or otherwise the mold would have had to be in two parts. The shaping was done by fitting on a ring or dish, which squeezed the top together, the inside being swept and smoothed by the fingers, after which the wet pot was stored in a warm place where it was slowly dried. When thoroughly dry it was placed in the annealing furnace, which was generally of sufficient size to accommodate enough pots for the day's run. The crucibles to be annealed were placed mouth downward on a bed of fire, separated by sufficient space to permit charging coke between them, which was also piled on top. Care was exercised to see that they were uniformly heated, the operation requiring about 22 hours. The pots were then removed and placed directly in the furnace, being given no opportunity to cool off.

Crucible Base.

It will be noted that each crucible had a hole in the bottom, made by the plug. This was not filled up with clay, as the crucible was cemented to its base. Each melting hole had a capacity of two crucibles, was rectangular in shape, and before the fires were lighted, the bases were placed in position on the grate bars. Live coals were then placed around them until the bars were covered with fire, level with the tops of the bases. The crucibles were then placed in position, coked up and the furnace allowed to run until it attained a white heat. At this stage, a couple handfuls of sand were thrown into each pot and allowed to melt, after which the sand set solid, filling up the hole and firmly cementing the crucible to its base, which thus became a part of the crucible. The pots were then ready for steeling and generally lasted a day's run of three heats each.

PHYSICAL PROPERTIES OF CAST IRON*

Fusibility, fluidity and casting temperature of cast iron, with a discussion of electrical, acid-resisting and other properties

By John Jermain Porter

IT SEEMS necessary to make some distinction between the total amount of fluid contraction and the tendency to form shrink holes in the heavy sections of small castings. At least there seems to be no very definite relation between chemical composition and this latter property and it is often the case that an iron low in graphite, and therefore having a high fluid contraction, will give sounder castings than another iron high in graphite and which would, therefore, require less feeding in a large casting. In the writer's opinion, this difference is probably due to some peculiarity in the manner of freezing, but the whole subject is as yet enveloped in obscurity.

Cook has found that two irons of practically identical chemical composition may give very different results as regards soundness when poured into small castings of heavy section and the writer can confirm this fact from his own experience. A convenient test has been developed by Cook to show the tendency of any particular brand of iron to trouble of this sort. This test consists in making a casting in the shape of a **K**, the branches having a cross-section of 1 inch square. On breaking off the oblique branches any tendency to sponginess or shrink holes will at once be evident in the fracture.

As previously stated, there has thus far been discovered no important relationship between this property and chemical composition. It rather appears to be something inherent in the brand of iron. The writer has been told that in one case an addition of phosphorus lessened the difficulty and it is a curious fact that in some instances at least the addition of a small amount of steel scrap to the mixture will act as a partial corrective.

The contraction of the solid mass does not take place uniformly as the casting cools, but in stages which are separated by periods of less contraction or even of actual expansion. The total shrinkage which perhaps includes also a portion of the shrinkage in the fluid mass is conveniently obtained by Keep's test, or by casting a test bar between iron yokes and determining the space between the end of the bar and the yoke after cooling.

This, however, tells nothing as to the manner of shrinkage or the temperature at which it takes place. To get this latter information we must determine the shrinkage curve, or in other words, the length of the test bar at each instant of time during cooling, starting from the instant when the bar has solidified just enough to have some slight strength.

Effect of Composition on Shrinkage.

The effect of composition on total shrinkage is given in concise form in the accompanying table.

To get the minimum shrinkage, an iron should be high in silicon, from 2 to 3 per cent, depending on the thickness, high in phosphorus, say, 0.75 to 1.25 per cent, as low as possible in sulphur, as high as possible in total carbon and with only enough manganese to care for the sulphur, or about 0.3 to 0.4 per cent. This will insure high graphite and hence low shrinkage in the casting. The iron will, however, be rather weak and it is something of a problem to get in one and the same iron considerable strength and at the same time very low shrinkage.

Relation of Composition to Shrinkage.

	Total shrinkage.
Silicon	Decreases by about 0.01 inch per foot for each 0.20 per cent.
Sulphur	Increases by about 0.01 inch per foot for each 0.03 per cent.
Phosphorus	Decreases by about 0.015 inch per foot for each 0.10 per cent.
Manganese	Increases by about 0.01 inch per foot for each 0.20 per cent.
Total carbon	Decreases

Stretch of Cast Iron.

By the term "stretch" West describes the power of cast iron to stretch when placed under strain during the cooling process. This property is undoubtedly of much importance in cast iron, since there are many castings which are called upon to exhibit it. An extreme case which is commonly cited is that of pulleys, the arms of which are placed in tension due to the quicker cooling of the rim and which must, therefore, either stretch or crack. There is no data regarding the effect of the various metalloids of cast iron on its power of stretching but in general, a soft iron will stretch more than a hard one. Almost the only data on this subject is given by West.

Fusibility of Cast Iron.

Fusibility, or the melting point of cast iron, must not be confounded with its fluidity, or ease of flow when molten. Fluidity is much the more important of these two properties, but fusibility is of some interest, particularly as it gives us a means of deciding intelligently in what order to charge metals in the cupola.

The investigations of Dr. Moldenke have shown that the fusibility of cast iron depends primarily on its combined carbon content and, to a less extent, on the amount of phosphorus present. The most fusible alloy of iron and carbon, containing 4.27 per cent carbon, should have a melting point of 2,195 degrees Fahr., and as the carbon decreases the melting point increases up to 2,730 degrees Fahr. for pure iron. Actually, we find that cast iron has a melting range varying from 2,000 degrees Fahr. for a white iron up to 2,300 degrees Fahr. for gray iron containing practically no combined carbon, this difference being due probably to the presence of silicon, sulphur, phosphorus and manganese.

Since the graphite in gray iron is only in mechanical mixture with the iron we should, perhaps, expect it to have no effect on the melting point. Moreover, it combines with the iron at temperatures below the melting point, thus increasing the combined carbon and lowering the melting point. For this reason gray iron melts at a lower temperature than steel having the same percentage of combined carbon.

As previously noted, phosphorus also has the effect of lowering the melting point of cast iron, but it is not nearly as powerful in its action

*Presented at the Detroit meeting of the American Foundrymen's Association.

as combined carbon. Iron containing 6.7 per cent phosphorus would melt at only 1,740 degrees Fahr., but with less phosphorus than this the melting point rises rapidly so that the 1 or 2 per cent in commercial high phosphorus irons makes very little difference in the melting point.

The accompanying table gives the melting points with analyses of some typical irons and ferro-alloys. It will be noted that the metalloids, other than carbon and phosphorus, such as silicon, sulphur and manganese, seem to have very little effect on the melting point.

Melting Points of Cast Irons.

Melting point. deg. Fahr.	Combined carbon. Per cent.	Graphitic carbon. Per cent.	Silicon. Per cent.	Manganese. Per cent.	Phosphorus. Per cent.	Sulphur. Per cent.	
2,030	3.98		0.14	0.10	0.22	0.037	Pig iron.
2,100	3.52	0.54	0.47	0.20	0.20	0.036	Pig iron.
2,140	2.27	1.80	0.45	1.10	1.46	0.032	Pig iron.
2,170	1.93	1.69	0.52	0.16	0.76	0.036	Pig iron.
2,200	1.69	2.40	1.81	0.49	1.60	0.060	Pig iron.
2,210	1.48	2.30	1.41	1.39	0.17	0.033	Pig iron.
2,230	1.12	2.66	1.13	0.24	0.089	0.027	Pig iron.
2,210	0.84	3.07	2.58	0.47	2.12	0.051	Pig iron.
2,250	0.80	3.16	1.29	0.50	0.22	0.020	Pig iron.
2,280	0.13	3.43	2.40	0.90	0.08	0.032	Pig iron.
2,350	1.32		0.21	0.49	?	?	Steel.
2,210	6.48	(carbon)	0.14	44.59	?	?	Ferro-manganese.
2,255	5.02	(carbon)	1.65	81.40	?	?	Ferro-manganese.
2,190	3.38	0.37	12.30	16.98	?	?	Silico-spiegel.
2,040	1.82	0.47	12.01	1.38	?	?	Ferro-silicon.
2,400	6.80	(carbon)	(chromium 62.70)				Ferro-chrome.
2,280			(tungsten 39.02)				Ferro-tungsten.

Fluidity.

Fluidity may be defined as ease of flow. It is synonymous with mobility and opposed to viscosity. It is a property of far-reaching importance to the foundryman and especially to the manufacturer of small and intricate castings. Unfortunately, our means of measuring fluidity are not very satisfactory, and this makes it difficult to determine quantitatively the effect of composition upon this property. About the most satisfactory method is to pour fluidity strips, or long strips of perhaps 1 square inch section and tapering to nothing at the other. The distance which the iron runs in a mold of this form is a rough measure of its fluidity.

The factors which govern fluidity are percentage of silicon, percentage of phosphorus, freedom from dissolved oxide and temperature above the melting point.

Silicon perhaps aids fluidity by causing a separation of graphite at the moment of solidification, thus, according to Field, liberating latent heat and prolonging the life of the metal. On this basis, high total carbon would also aid fluidity by increasing the amount of graphite separated.

Phosphorus is probably the most important element as regards fluidity, high phosphorus causing a marked increase in this property. The best results are obtained with about 1.5 per cent phosphorus, although for other reasons it is seldom desirable to use as much as that.

Freedom from oxide is a very important point, as its presence makes the metal sluggish and causes it to set quickly. It is a frequent and often unsuspected source of trouble.

Temperature.

The temperature above the freezing point is probably the most important factor of all in connection with fluidity, and it should here be noted that a distinction is made between freezing point and melting point. The two may coincide in the case of white iron, but will not usually, especially with gray iron. This is because, as we have already seen, gray irons have a melting temperature corresponding to their percentage of combined carbon rather than total carbon. After they are in the molten state, however, all the carbon is in soltion (combined as far as melting points are concerned), hence the freezing point will correspond more nearly to the melting point of a white iron having the percentage of combined carbon equal to the total carbon of the original gray iron. This will be in general from 100 to 300 degrees lower than its melting point. For this reason, when gray irons are melted they are always considerably superheated above their solidifying points, and the greater this superheat, the more fluid the iron. Evidently, the superheat due to this cause will be the greater the lower the combined carbon in the iron going into the cupola.

Practical rules for getting fluid iron are as follows:

Keep the phosphorus high, up to 1.00 to 1.25 per cent if possible.

If the work will permit, use a soft iron of 2 per cent or over in silicon and low in combined carbon.

Avoid oxidizing conditions in melting, and if necessary, use deoxodizing agents.

Use plenty of coke and good cupola practice.

Resistance to Heat.

Ability to withstand high temperatures is of paramount importance in several classes of castings such as grate bars, ingot molds, annealing boxes, etc., and the factors which affect this ability are the percentage of phosphorus, sulphur and combined carbon, and the density or closeness of grain.

Phosphorus forms with iron an alloy which melts at only 1,740 degrees Fahr., or about 400 degrees lower than cast iron free from phosphorus, and each per cent of phosphorus present gives rise to 15 per cent of this easily fusible constituent. Now, it will be evident that the presence of a molten constituent in a piece of iron must greatly weaken it, and hence it is that the presence of much phosphorus decreases the resistance of cast iron to heat.

Sulphur acts in a similar manner to phosphorus since it also forms with iron a constituent of low melting point, 1,780 degrees Fahr. It is, therefore, detrimental to castings which have to stand high temperatures.

Combined carbon is the element, which, more than any other, determines the melting point of cast iron, this melting point becoming lower with increase in this element. It would seem then, that combined carbon must be very detrimental in this class of castings. However, it should be remembered that the condition of the carbon in the solid iron changes readily at high temperatures, and, hence, after the casting has been in use for a while its combined carbon content will not in general be the same as when cast. This fact makes the question of combined carbon of much less practical importance than either phosphorus or sulphur.

Density or close grain is commonly stated to render cast iron considerably more resistant to the effects of heat.

Growth of Cast Iron.

One feature of the effect of heat on cast iron, which deserves especial mention, is the permanent expansion which

it undergoes on repeated heatings. This peculiar behavior was first discovered by Outerbridge, and has since been also investigated by Rugan and Carpenter.

The extent to which this growth may take place is certainly surprising, the increase being in some cases as high as 46 per cent by volume and 1¾ inches in the length of a 15-inch bar. The strength of the metal is decreased proportionately to the expansion or to about one-half of the original strength. Both the expansion and the decrease in strength are explained by microscopic examination which shows minute cracks throughout the interior of the metal. Outerbridge found that in his experiments the increase in hardness was accompanied by no increase in weight and that the specific gravity of the metal was decreased from the original 7.13 to 5.49. Rugan and Carpenter, on the other hand, found invariably an increase in the weight of the expanded bars due to the absorption of oxygen by the metal.

Repeated Heating.

Two conditions are necessary for this growth. First, repeated heating, and second, a proper composition of the metal. With regard to the heating, a minimum temperature of 1,200 degrees Fahr, is necessary. At 1,400 to 1,600 degrees the rate of growth is more rapid and an increase in temperature beyond 1,700 degrees produces no additional effect. Both heating and cooling are necessary to procure the growth and the time of heating makes very little difference. No greater growth was produced by 17 hours continuous heating than by 4 hours. The number of heatings required to produce the maximum amount of growth varies with different irons, but usually lies somewhere between 50 and 100.

Effects of Composition.

Regarding the effects of composition, it appears that the growth is favored by the presence of graphite and silicon, and also by a large grain or open structure. White iron containing no graphite expands slightly when subjected to this treatment but not sufficiently to overcome its original shrinkage. In this case the expansion is due to the conversion of the combined carbon into the temper form, or in other words, to the malleableizing of the casting. Soft irons, low in combined carbon and high in silicon, show the greatest increase in volume. The effects of sulphur, manganese and phosphorus have not been investigated. Steel and wrought iron are not subject to this growth, but on the contrary undergo a slight permanent contraction when repeatedly heated.

Authorities differ as to the explanation of this phenomenon. Outerbridge attributes it to the "mobility of the molecules of cast iron," while Rugan and Carpenter conclude that it is due to the oxidation of the iron silicide by air admitted through minute cracks opened up along the faces of the graphite crystals, or in some cases, to pressure exerted by the expansion of the occluded gases. To the writer it seems that this growth must be due to the fact that iron undergoes a change in volume coincident with the change from the *alpha* to the *gamma* form when heated to its critical temperature of about 1,300 degrees Fahr., and that the mechanical interference of the graphite crystals prevents the return of the iron crystals to their original positions in the subsequent cooling. This explanation is, perhaps, only an amplification of that of Mr. Outerbridge.

It is evident that this property of cast iron is of great importance in many of the applications of the metal and limits its use for many purposes. It is, no doubt, the reason why a close-grained iron gives better results when exposed to high temperatures and affords an explanation for the warping of grate bars, annealing boxes and similar castings. It also shows why chills and permanent molds must not be allowed to be heated to redness, such a degree of heat resulting in permanent expansion and the loss of their original dimensions.

Composition of Castings Exposed to High Temperatures.

The following is a summary of some of the published statements regarding the proper composition for castings exposed to high temperatures:

Cast iron to withstand high temperatures should be low in phosphorus and combined carbon.

In car wheels, manganese increases the resistance to heat strain.

For refractory castings, choose a fine grain cast iron, best containing about 2 per cent manganese to retard the separation of amorphous carbon.

Castings to resist heat should contain about 1.80 per cent silicon, 0.03 per cent sulphur, 0.70 per cent phosphorus, 0.60 per cent manganese and 2.90 per cent total carbon. Low sulphur is of chief importance, low silicon, carbon and manganese are also advisable.

Close-grained cast iron having the greatest density will invariably be found best to withstand chemical influences and high temperatures.

A chill which had given excellent service had the following composition: Silicon 2.07 per cent, sulphur 0.073 per cent, phosphorus 0.03 per cent, manganese 0.48 per cent, combined carbon 0.23 per cent, graphitic carbon 2.41 per cent, total carbon 2.64 per cent.

Two permanent molds which had given excellent service analyzed as follows: (1) Silicon 2.15 per cent, sulphur 0.086 per cent, phosphorus 1.26 per cent, manganese 0.41 per cent, combined carbon 0.13 per cent, graphitic carbon 3.17 per cent, total carbon 3.30 per cent. (2) Silicon 2.02 per cent, sulphur 0.070 per cent, phosphorus 0.89 per cent, manganese 0.29 per cent, combined carbon 0.84 per cent, graphitic carbon 2.76 per cent, total carbon 3.60 per cent.

Ingot molds and stools are best made from medium soft iron low in phosphorus, or what is termed a regular Bessemer iron.

It will be noted that some of these statements are quite contradictory, which simply means that it is not absolutely necessary for a casting to fulfill all of the requirements which we have previously discussed in order to give satisfactory service. It is, however, probable that had all these conditions been fulfilled the service would have been even more satisfactory.

Behavior at Low Temperatures.

It is well known that steel becomes much more brittle at low temperatures and this fact is reflected in specifications for steel rails which are to be used in very cold climates. It is not known whether the strength and other properties of cast iron are materially affected by intense cold. Even if so, its influence cannot be great and the subject is of comparatively small importance. Dewar and Hadfield have carried out experiments on the properties of metals at the temperature of liquid air and find in the case of iron and steel an increase in strength and a decrease in ductility. The presence of manganese increases the brittleness due to cold while the presence of nickel and manganese together lessens this brittleness.

Electrical Properties.

Of the three electrical properties, conductivity, permeability, and hysteresis, the second only is of importance in connection with cast iron.

Little is known regarding the relation between chemical composition and conductivity of cast iron. In the case of steel it has been found that manganese is the element most injurious to this property with carbon a close second. Hence, by analogy we may infer that to make iron castings of high conductivity we should keep both the manganese and combined carbon as low as possible.

Permeability may be defined as magnetic conductivity and is of importance in many castings used in the construction of electrical machinery. Permea-

bility data is generally given in the form of a curve expressing the relation between the magnetizing force H and the resulting field strength or number of lines of magnetic force per unit area B. This is known as the permeability curve. The permeability is the ratio $\frac{B}{H}$ and it will be noted that it is different for each value of the magnetizing force, H but approaches a constant or saturation value for high values of H.

The effects of the various elements on permeability are not yet entirely clear although there is some published data along this line. The writer has recently done considerable work on the relation between permeability and chemical composition of cast iron. It was found that the effects of silicon, phosphorus and aluminum are not well marked and are probably not of any very great importance. On the other hand, manganese has a very detrimental effect on this property.

In the writer's opinion these bad effects of manganese are due to its action in retarding the change from *alpha* to *gamma* iron. It is well known that *gamma* iron is non-magnetic.

Silicon has the opposite effect from manganese in that it accelerates this change in the form of the iron, and we would, therefore, expect it to have a more or less beneficial influence. Silicon steel has achieved a wide reputation as a high permeability material for use in the construction of transformer cores, etc. According to the author's results high silicon is particularly effective in increasing B for *low* values of H.

For high permeability, the lower the carbon the better, and excellent results are now being obtained through the use of semi-steel for electrical castings. In this connection, however, it must be remembered that manganese is undesirable and hence must be used cautiously as a deoxidizer in this class of work.

Rules for Obtaining High Permeability.

Some practical rules for obtaining high permeability iron are given herewith:

Keep the silicon high, best in the neighborhood of 3 per cent.

Keep the manganese low, preferably below 0.05 per cent.

If practicable, keep the carbon low by the use of steel scrap or air furnace iron.

Allow the castings to anneal themselves, that is, to cool completely in the sand before shaking out.

Hysteresis, like conductivity, is seldom or never of importance in cast iron. The property may be defined as the loss of energy due to molecular friction when magnetic polarity is reversed. The effect of composition upon hysteresis is in general about the same as in the case of permeability.

Resistance to Corrosion.

The relation of the composition of cast iron to its resistance to corrosion has apparently never been systematically studied and the little that is known on the subject is, for the most part, carefully guarded by the possessors of the information. Although there are a great many corrosive agencies it is not practicable, because of lack of information, to treat of each separately, and so far as we know the effects of composition would be relatively the same for the various corroding agents.

The following is a summary of most of the published information along this line:

Pig iron which best resists acids contains silicon 1 per cent, phosphorus 0.5 per cent, sulphur 0.05 per cent and carbon 3.0 per cent.

Excellent results with respect to resistance to corrosion by acids were obtained through the use of a mixture of three brands of pig iron *A, B* and *C* in the proportion, two parts of *A*, one part *B* and one part *C*. The analysis of the pig irons is as follows: (A) Dark gray fracture: Silicon 3.50 per cent, manganese 0.5 per cent, phosphorus 0.20 per cent and total carbon 3.80 per cent; (B) Light gray fracture: Silicon 1.50 per cent, manganese 0.40 per cent, phosphorus 0.20 per cent and total carbon 3.50 per cent; (C) Mottled fracture: Silicon 0.70 per cent, manganese 0.25 per cent, phosphorus 0.20 per cent and total carbon 3.50 per cent.

Acid Resisting Castings.

The composition of acid-resisting castings should be about as follows: Silicon 0.8 to 2.0 per cent, sulphur 0.02 to 0.03 per cent, phosphorus 0.40 to 0.60 per cent, manganese 1 to 2 per cent and total carbon 3 to 3.5 per cent, and, in addition, the metal should be as free as possible from oxide.

Cast iron to withstand the corrosive action of molten chemicals should be close-grained and dense. The iron having the greatest density will invariably be found to best withstand chemical influences and high temperatures. The addition of deoxidizing agents is of great benefit.

Gray iron is attacked by acids about three times as fast as white iron. In cases where it is not practicable to use white iron castings it is sometimes possible to cast against chills in such a manner as to form a white iron surface to resist corrosion, and still leaving the body of the casting gray.

In a series of tests on the acid-resisting properties of some well known English brands of iron, the No. 1 iron, presumably high in silicon, and the "hematite," low in phosphorus and probably high in silicon, gave the best results.

Ferro-silicons with high percentages of silicon, 20 per cent and over, are remarkably resistant to the effects of acids and are being made into vessels for use in the chemical industries.

Sulphur has been found to be a source of corrosion in steel in some instances, causing pitting at points where manganese sulphide has segregated.

It has been shown that the presence of small amounts of copper in steel and puddled iron diminish their tendency to rust.

Pertinent Suggestions.

Some practical rules for obtaining castings, resistant to corrosion, are as follows:

Use white iron if practicable.

If not practicable to use white iron castings, chill those surfaces which are to be in contact with the corrosive substances.

If gray iron must be used get dense, close-grained castings through the use of steel scrap or otherwise.

Avoid oxidized metal, use good cupola practice and good pig irons. If possible use deoxidizing agents.

Keep the sulphur just as low as possible.

Resistance to Wear.

We must first make some distinction between two cases of wear typified by a grinding roll and a brake shoe. The first case may be dismissed by the simple statement that the greater the hardness the better the wear, providing at the same time that the iron is sufficiently strong.

In the second case, however, it is necessary that the casting should not be so hard as to unduly wear the material with which it comes in contact. For example, the brake shoe must be softer than the tread of the car wheel. There is no theory to guide us in the matter and the rules given are the results of experience chiefly with brake shoes.

Too much silicon gives an open, soft iron which does not wear well. The best results are obtained with silicon about 1½ per cent in castings of medium thickness.

Sulphur is claimed by many to be advantageous in castings for frictional wear because it closes the grain and hardens somewhat. Diller records a peculiar occurrence of a hard spot, which could not be machined, a smooth surface being formed which wore the drill, although it could be dented with a center punch. Analysis showed 0.20 per cent sulphur and 0.50 per cent combined carbon.

Phosphorus is best kept moderately low. Most specifications call for 0.75 per cent or under. It is injurious probably because it weakens the iron at the high temperature sometimes produced by friction.

Manganese is best kept moderately high to take care of the sulphur. Most

brake shoe specifications call for under 0.70 per cent.

The addition of steel scrap to the mixture has been found to give excellent results for this class of work, probably owing to the reduction in the total carbon and to its action in closing the grain.

Coefficient of Friction.

There is no data as to the relation between the composition of cast iron and its coefficient of friction. Since graphite is an excellent lubricant it is probable that the percentage of graphite is the controlling factor here, the friction decreasing with increase in this element. From theoretical considerations we should expect the best results to be obtained with a very soft iron low in sulphur, manganese and combined carbon, and high in graphite.

Casting Properties.

The properties which remain to be considered pertain more particularly to the casting as a whole and are chiefly influenced by the design, molding and pouring of the casting, and to a very much less extent, by the composition of the metal.

Unsoundness, due to the presence of blow-holes and shrinkage cavities, while usually resulting from bad practice in molding may also be caused by poor quality of metal. Blow-holes may be caused by oxidized metal or by excessive sulphur. When caused by sulphur, the remedy is to decrease this element. Raising the manganese is often effective in preventing blow-holes since it acts both as a deoxidizer and desulphurizer. Scott states that manganese below 0.25 often results in blow-holes. High phosphorus sometimes acts as a corrective of blow-holes due to its prolonging the fluidity, thus giving the iron more chance to release the dissolved gases.

Dirty Castings.

Dirty castings are also caused chiefly by poor molding, pouring or cupola practice. Occasionally, however, it may result from wrong composition of the metal, and the points chiefly to be watched are to keep the sulphur low; to avoid kish, or segregated graphite; and to avoid oxidized metal.

Sulphur tends to cause dirty castings because it makes the iron congeal more quickly, and hence any dirt present has less chance to separate. In addition, the sulphides of iron and manganese themselves form dirt spots when segregated. Kish is usually caused by too much silicon, or sometimes by too much total carbon. Oxidized metal is a prolific source of dirty castings but the oxidation is usually due to bad cupola practice or to the use of oxidized scrap. Moderately high manganese and phosphorus are conducive to clean castings, the first because it takes care of sulphur and oxidation and the second because it increases the fluidity of the metal and thus gives the dirt a better chance to float out.

Porosity.

Porosity is usually caused by the presence of kish. Pin holes, another form of porosity, are usually due to excessive sulphur in the form of iron sulphide. This compound retains gases in solution until the metal is partially frozen and then releases them in the form of tiny bubbles which give rise to this defect. Decrease in sulphur or increase in manganese or both is the remedy.

Segregation.

Segregation proper is caused by the difference in melting point and specific gravity of the several constituents of cast iron. The constituents of lowest melting point are the phosphorus and sulphur compounds and it is, therefore, in these cases that we find the greatest tendency towards segregation. It is not unusual to find hard spots in heavy castings high in phosphorus which are caused by the phosphide being squeezed out into blow-holes formed during solidification. Frequently the phosphide does not completely fill the cavity, or fills it as a loose globule. The sulphides, owing to their low specific gravity, usually segregate in the top of the casting and it is not infrequent to find several times the normal amount of sulphur in the upper part of heavy castings. Manganese sulphide segregates more readily than iron sulphide.

Besides segregation proper, we sometimes find cases of non-homogeneity due to other causes. Occasionally, spots of white iron are found in the interior of castings. It has always been difficult to account for these but the clew is given by the fact that they are invariably found in castings poured from the first metal tapped. Undoubtedly they are caused by the iron boiling on the sand bed and are connected in some way with the partial Bessemerizing of the metal. Again, hard spots in castings are sometimes due to small pieces of metal, as for example, small steel scrap and shot iron, being incompletely melted in their passage through the cupola. Ferro-manganese and other ferro-alloys may give rise to this same trouble through incomplete solution when stirred into the ladle.

Crystallization in cast iron is an important subject but one which need not receive attention here, since, as a source of weakness, it is influenced by the design of the casting rather than by the composition of the metal.

Shrinkage Strains.

Shrinkage strains are caused primarily by wrongly designed castings, but the trouble may be aggravated by the composition of the metal. High sulphur is a particularly prolific source of internal stresses and, in general, the greater the total shrinkage the greater the strains due to this cause.

As all foundrymen know, the fineness of finish and smoothness of skin of a casting depend chiefly on the sands and facings used and the skill of the molder. High phosphorus in the iron, however, is a considerable aid in getting the fine skin desired in ornamental work. Another element which affects the skin is manganese, which has the rather peculiar action of causing the sand to peel from the castings with extreme readiness. With 1 per cent manganese this tendency is evident and with 2 per cent it is very marked.

Sand Matches

Question:—We would like a good formula for making oil and litharge matches. The proportions we have been using do not give us the wear we think we should have. We have heard of the use of cement in connection with the above ingredients. What is your opinion of such a mixture?

Answer:—An excellent formula for oil matches was given on page 15 of the September, 1910, issue of THE FOUNDRY. Another method is to take well-burned molding sand from castings that have been cleaned with a wire brush and riddle through a No. 12 sieve. If raw linseed oil is to be used, mix 1 part of litharge to 16 in bulk of sand, then mix in the oil, making the sand as wet as possible but not sufficiently moist to adhere to the patterns. Mix the mass thoroughly and pass through a ½-inch riddle, rubbing it through with the hand, but not shaking it through. Ram the match frame bed on a board and roll over and after the drag is removed, strengthen all soft rammed parts of the match by building up with the oil sand, then brad all sharp edges and places where the pattern strikes; next draw the patterns and slick the match all over with a small tool. Touch up the high spots and ragged edges with oil and slick smooth again, then let the match have plenty of time to dry, and should

there be any danger of its dropping out, drive nails through the face of the match into the bottom board at intervals, as thought necessary. Cement is used for making matches in connection with plaster of paris, but not to our knowledge with oil. It can, however, be easily tried by being mixed with the sand before the oil is added. When used with plaster of paris, the proportions sometimes are 1 part cement; 1 part plaster of paris, and 2 parts lake sand, mixed with water. When using boiled linseed oil for oil sand matches, the addition of litharge is unnecessary, as the oil will dry rapidly enough without the use of any dryer.

Melting Crucible Steel

Question:—We desire to know whether coke can be successfully used for melting crucible steel, and what size of furnace and blower would be necessary to melt 100 pounds. We have tried to melt steel several times, but have not experienced much success, as we melted the bottom out of the crucible, but failed to melt the steel.

Answer:—Crucible steel can be successfully melted with coke in straight shaft furnaces. The operation however, is slower, more laborious, and more uncertain of uniform results, than with the usual type of oil furnace. Success or failure with coke furnaces depends largely upon the manner in which the stoking is done, and this in turn upon the physical condition of the operator and his ability to perform arduous, exhausting labor in the face of intense heat. These remarks apply to the melting of low carbon steel in coke furnaces suitable for castings, and not to tool steel. Ordinary, coke-fired brass melting furnaces, set in batteries connected to a stack, can not be used for melting steel, as the necessary heat cannot be developed in them, even with a blower. Coke holes for melting low carbon steel, should be deeper than those used in brass melting, and not more than two should be connected to a stack. The height of the stack should not be less than 45 feet, and each furnace should be independently connected to the stack, so that when one is idle the draft of the other will not be affected. The flue connecting the furnace with the stack cannot be made of cast iron, as is usual with brass furnaces, as the high temperature would melt the iron. Therefore, it must be constructed entirely of fire brick with all joints perfectly tight. The depth of the furnace should be 36 inches, the diameter at the top 20 inches, and at the bottom, 22 inches. The inside tapers upwards slightly, which facilitates the coking operation. The crucibles, when new, will hold about 95 pounds of steel charged cold in the form of boiler punchings or Swedish iron, and are set upon a base which rests on the grate bars. This base is 9 inches in height, the same diameter as the bottom of the crucible, and should be purchased from a crucible maker, as it will be found exceedingly difficult to get fire brick that will withstand the intense heat without fusing. This base is a most important factor in melting steel with coke, as melting cannot be accomplished without it, no matter how much fuel is consumed. Without the base the crucible will gradually settle onto the grate bars before the steel becomes fluid, and raising the pot will chill the contents. A good blast furnace brick can also be used as a base. The crucible must be covered with a lid, which can be formed by chopping off the bottom of an old crucible and knocking a hole in the center. This is luted onto the filled crucible with fire clay, and after the pot is in the furnace, the hole is covered with a piece of brick. The fire can be lighted before the crucible is placed in the furnace, but great care must be exercised to prevent coke from getting between the crucible and the base, as it will punch a hole through the bottom when the pot becomes plastic from the heat. The crucible is coked around the side like a brass pot, using 72-hour fuel, and is also completely buried with the coke. The furnace is filled with fuel as much as much as is possible without obstructing the draft. The cover is then rolled on, sealed with sand and allowed to run for 45 minutes, the condition of the heat being observed through the hole in the cover from time to time. Under no circumstances should the furnace be opened until it has attained a white heat. The cover is then slightly rolled back and the furnace is stoked by vigorously poking down the coke to the grate bars with an iron bar. It is absolutely necessary to obtain a high temperature around the bottom of the crucible, and no clinkers should be allowed to form. The bar, therefore, must be driven down straight, hitting the grate bars at every stroke, and pushing down the reserve supply of hot coke that was piled on top of the pot. On this part of the operation, the success of melting with coke hinges. No shirking on the part of the melter can be tolerated, otherwise the furnace will scaffold, a clinker being formed between the top of the base and the sides of the furnace. In this case the metal will be melted on top and will be solid in the bottom. When the pot has been poked down, coke is again thrown on top, and the furnace sealed, the progress of the melt being observed through the hole in the cover as before. After two or three cokings it is well to push aside the brick from the hole in the crucible cover and to insert a one-half-inch iron rod to feel the metal. When the contents of the crucible are fluid, and the rod comes out covered only with a coating of slag, the metal is ready for the final additions of ferro-alloys which are necessary to eliminate gases. Five minutes after the additions, the steel can be poured. The time of melting in this type of coke hole furnace will probably be five hours for the first heat and 3½ hours for the second. Two heats only can be obtained in a working day. The crucibles used should be the standard steel pots which can be purchased from crucible manufacturers. Crucibles intended for brass will not stand the heat, but will soften and collapse while being removed from the furnace. With good steel crucibles the writer has obtained as many as eight heats of low carbon steel melted by coke in the manner stated.

Pickling Castings

For pickling iron castings, the strength of the solution is generally 1 part sulphuric acid to 10 parts water, and the castings are left in the dip for several hours or in some cases, over night, but for large castings, or where the capacity of the dipping tank is not sufficient to accommodate the work, the solution may be stronger and in the proportion of one part sulphuric acid to 4 parts water. The castings are merely immersed in the pickle and are then laid aside for eight or twelve hours, or until covered with a white powdery deposit, when they are rinsed in hot water. When the scale is so firmly attached that one treatment is not sufficient to remove it, the operation can be repeated until the desired effect is produced.

ELEMENTS of PATTERN CONSTRUCTION-V

Comprehensive discussion of the taper of pa - terns and the utility of loose pieces on patterns

By Joseph Horner

PROVIDING for draught or taper on patterns is not a matter that concerns the molder alone. It is often a source of trouble to the machinist and fitter for the reason that imparting taper involves variable dimensions in the castings in which it occurs. This affords one of the strong arguments, among several, why the product of molding machines is preferred to that of hand-molded patterns. In the latter the amount of taper is a variable quantity, depending not only on the amount embodied in the pattern, but also on the muscle of the molder, and the energy with which it is expended on the rapping bar.

Proper Amount of Taper.

Though the amount of taper which is given is often excessive, and unnecessary, it is not always because of this excess that taper is objected to. It depends somewhat on the character of the work itself. In a rough class of castings, the parts of which are not mutually fitting, it matters little. In castings that are machined a little excess of taper is of no account. But in castings which are not tooled, but where pieces have to match, as occurs in parts of agricultural work, cheap crane work, builders' tackle, etc., any taper is objectionable. Before the days of wheel molding by machine it was quite a common practice, when it could be adopted, to reverse the teeth of gears, that is, to gear them together so that the top side of one wheel, as molded, should engage with the bottom side of its fellow. By this means a fair bearing of the teeth along their whole length was insured. Under the opposite conditions the strain on the teeth would be concentrated at one corner or end—the top in molding—until they had worn themselves into mutual contact.

Another illustration occurs in matching faces. Standards or legs for carrying beds often have a beading cast around their top edges, or they have a convex finish extending out wider than the bed. Many might think these and similar examples were designed for ornamental effects. On the contrary, they are adopted to mask the taper in the standards. When this is not done, there is always some chipping and filing at the joint, unless indeed the overlap is left to be a perpetual eyesore.

Although the patternmaker and molder have to regard taper essentially and primarily from the point of view of free delivery, the objections of the machinist and fitter and the management may not be disregarded. Castings must be suitable for their purpose, and if one method of molding will not give the results demanded, then another or others must be considered.

Taper Depends Upon the Pattern.

The amount of taper required depends, to a large extent, upon the way in which patterns are made. The best made patterns require the least, because care is taken to impart the taper by fine shavings, to obliterate all slight ridges by glass papering, to make the surface smooth and hard with applications of varnish, and to give ample provision by means of rapping and lifting plates or with straps for lifting. In metal patterns, where the highest surface smoothness exists, which are usually coerced in a truly vertical movement by means of a machine during withdrawal from the mold, the very minimum of taper is imparted. The same remark applies to the pattern teeth of machine-molded wheels, which are withdrawn by the arm of the machine, and which, though made of wood, have no appreciable quantity of taper.

It will be understood that definite rules for quantities of taper can hardly be of value. Generally, one would say, that a total of ⅛ inch per foot of depth is suitable for general work. Actually, this seldom need be exceeded, though more is given in a rough class of work; but it must often be less. Half that amount is sufficient in well-made patterns, and less still in good metal patterns. But in considering loose pieces later we shall see how greatly the quantity of taper is modified by the location of such pieces. There is, therefore, more in the question of taper than is at first apparent. It is possible to impart a large amount of taper in such a way as to be of little or no aid to the molder, and also to make a little taper of material help.

Necessity for Draught.

First, consider the operation which renders taper or draught necessary. The sand is rammed very firmly around the pattern, so firmly that all patterns of large and even of moderate depth require the power of a crane, or of several men to effect their withdrawal. And it is not sufficient to pull a pattern out of the sand by mere brute force, regardless of the result to the pattern and to the mold. The pattern must be preserved intact, and the mold also; the first for future use, the second in order to insure the correct shape and size of the casting. The more perfectly the mold receives and retains the impression of the pattern, the less work is entailed on the molder, and the more nearly will the casting resemble the pattern in dimensions, because a mold that has been patched is not so accurate as one which is left unbroken from the pattern. The amount of taper should be so proportioned that the pattern will deliver with the least possible risk of fracture of the mold, while its amount must not be so excessive as to interfere with the subsequent uses to which the casting has to be applied. Obviously, too, the amount of taper must depend on the depth of the pattern, so that a very deep pattern will require a large quantity, while a very shallow one need not have any at all.

Again, the deeper and larger patterns are, the more severe must be the rapping to which they are subjected, and this is a fruitful cause of distortion in molds. In small, shallow patterns, the rapping is only of the slightest—a mere jarring; in deep patterns the rapping bar is hammered sideways all round with a hand hammer or with a sledge. This is absolutely essential to effect the loosening of the pattern from the sand, except in those cases where stripping plates are used, or where a steady withdrawal of comparatively shallow patterns by machine, without stripping plates, is adopted, and these, too, often have jarring mechanism.

Effect of Draught in Molding.

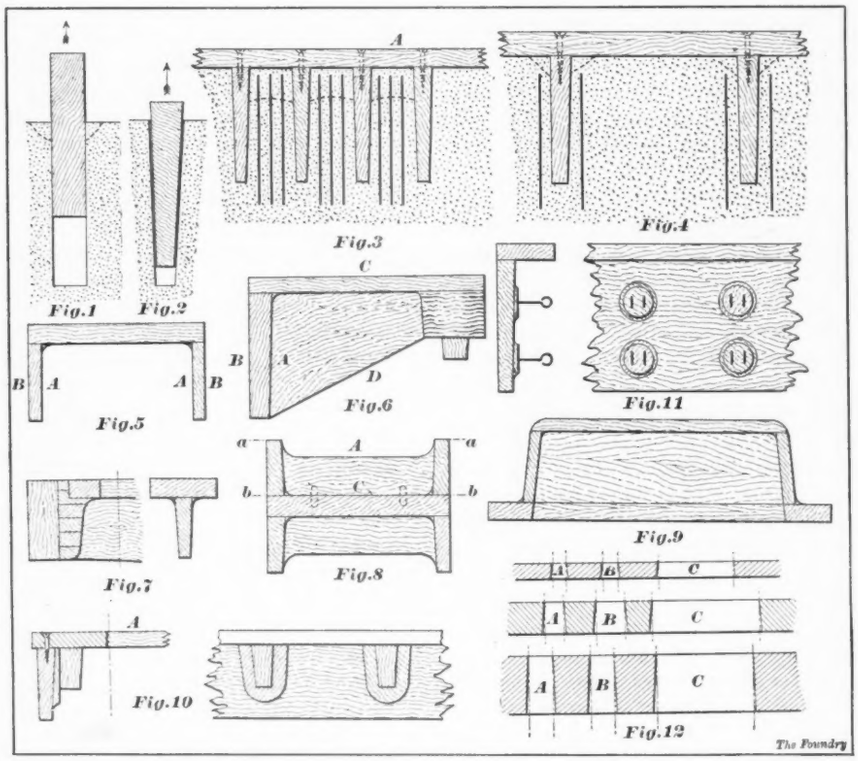
The effect of taper is seen by comparing Figs. 1 and 2, showing ribs which have to be withdrawn from the enclosing sand in the direction of the arrows. In Fig. 1, with no taper, the sand is fractured diagonally at the joint face, and the pattern faces are dragged against the sand faces all the way up without any lessening of friction. In Fig. 2, as soon as the larger portion has been fairly started out, actual contact

ceases, and the molder only has to take the weight of the pattern and lift steadily, "feeling" his lift, to keep the pattern from frictional contact with the sides of the mold.

There are various reasons why, apart from those already stated, the taper in patterns is varied in amount. Take first the case of several vertical ribs adjacent, Fig. 3. If these occur in very close proximity, then it is necessary to give more taper to them than when they are farther apart, or when there is a single rib only. In the case of Fig. 3, the narrow sections of sand are much more likely to fracture than the larger masses in Fig. 4. The reason lies in the narrowness of the sand, which is not a substitute for rodding which is necessary to afford support to the sand during pouring, but simply prevents the friction of withdrawal from tearing up the narrow masses.

Draught on Inside and Outside Faces.

For a similar reason, it is preferable to impart more taper to the interior faces, *A*, of vertical ribs, Fig. 5, than to the exterior, *B*. But in many cases this is done for another reason; in order to put all or nearly all taper to faces which are not working faces, leaving the latter square, or nearly so. Thus, in the bracket, Fig. 6, almost all the taper would be given to the inner face, *A*, and the outer one, *B*, would be



would be likely to break bodily across as indicated by the dotted lines, by the friction of the withdrawal, while in Fig. 4, the angular portions only, similarly in ated near the top face, would be liable to fracture. Deep and narrow masses of sand have, therefore, to be rodded as in Fig. 3, to afford support to the sand, while in Fig. 4, the rods, though affording security, are often omitted, or placed only adjacent to the ribs, as shown. It is also desirable, when the work is such as to allow of the separation of the flat plated portion, *A*, Fig. 3, from the deep ribs by unscrewing it, to do that, and withdraw the ribs separately. Flat pieces of board are then often laid on top of the masses of sand and weighted, holding the sand down similarly to a stripping plate during the withdrawal of the ribs. This almost square with face, *C*, that is, it would not be tapered more than by the amount of the thickness of two or three shavings—sufficient to allow of the light being seen under a try square when the stock is laid on face, *C*, and the blade down the face, *B*. But in the rib, *D*, the taper would be symmetrically arranged. Provided, therefore, a taper is given, it is not essential that it be symmetrical about the center plane of the lift. In the case of ribs that have no working faces, the taper is equalized as in Figs. 3 and 4, but in instances where one face is a working face, as in flanges and brackets which have to be bolted to other faces, no draught at all, or but the merest trifle is given to those faces, all the taper being imparted to the non-working face, as in Fig. 6. Fig. 7 represents the difference between the rim of a gear wheel which has no taper or only the merest shade on the rim, which carries the teeth, while the draught lies within the rim, but the arms at the right are tapered symmetrically. If having one face vertical is not quite so satisfactory, from the molder's point of view as both faces tapered equally, a good lift can nevertheless be obtained with the occurrence sometimes of just a little "dragging" or roughening up of the perpendicular face of the mold which can be smoothed with the blade of the cleaner.

Deep Patterns.

In lifts having any considerable depth, the castings will not come out with faces as true as those of the pattern, because of the rapping, which causes slight enlargement of the mold at and near the joint face. For this reason the broad feet of brackets, when molded "up and down," and the faces of pipe and column flanges of large size, and work of this class, never come out true, but the faces slope away slightly from each other from the joints. In all work of this kind, therefore, the faces must either be tooled, or chipping or planing strips be cast on, or if the cost of these is objectionable, as in some of the cheaper kinds of work, then arrangements must be made to lift the whole face from the top, Fig. 8, *aa*, instead of jointing along *bb*, or, in some cases of flanged work, to form the face in a single, broad, true core, each of which devices is adopted. In the joist or girder section of the casting in Fig. 8, a joint would never be made along *bb* unless the work were complicated by some additional parts which might render it desirable. The upper ribs, *A*, must either be left loosely dowelled, or a large quantity of taper must be imparted to them. The top face of the mold extends from *aa* down to *c*, the bottom part from *aa*, outside and downward.

Taper may be imparted, not in the thickness of the material, but by throwing it out of plumb. Thus, a pattern of the type shown in Fig. 9, is often tapered, as illustrated. The sides are planed of parallel thickness, but they are canted out of perpendicular to the amount required for draught. The amount is slightly exaggerated in the drawing, to make the method clear. In a depth of 6 inches, about ⅛ inch of taper would be given. This is a method applicable in many cases, especially in deep work cast solidly. The outside and top of the mold are withdrawn vertically and the pattern portions in the same direction, leaving the lower part of the mold and its interior standing.

Tapering vertical faces sometimes renders boss facings for bolts desirable.

THE FOUNDRY DATA SHEET, DECEMBER, 1910.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

FORMULAS FOR THE BRASS FOUNDRYMAN.

Red Brass For Small Castings.

For small castings that must be rapidly finished by automatic machines a free cutting metal of a good red color is required. These qualities are obtained by the use of lead instead of tin or zinc as the principal part of the alloy, thus producing an imitation gun metal that casts well, has a fine bronze color when cut, and makes clean, bright castings. A formula frequently used is as follows:

	Pounds.
Copper	87
Lead	8
Zinc	2
Tin	3

Melt the copper under a cover of charcoal, then add the tin and zinc and lastly the lead, stirring thoroughly.

This alloy will be found very easy to machine and is extensively used for the manufacture of plumbers' red brass fittings. The addition of some other metal, such as zinc or tin, is necessary in copper and lead alloys, even when the proportion of lead is comparatively small, otherwise this metal will sweat out of the mixture and the castings will be marred by dark colored spots scattered over the surface, or the lead will ooze out in minute beads, which, when the castings are tumbled, batter up and produce very unsightly castings. The proportions of tin and zinc, given in the formula, will prevent this condition, and sometimes the zinc is increased to produce a cheaper alloy, as in the following:

	Pounds.
Copper	82
Lead	8
Zinc	8
Tin	2

These alloys, although very useful in their proper sphere, are not recommended for castings subjected to steam pressures.

FORMULAS FOR THE BRASS FOUNDRYMAN.

White Brass.

True white brass is the alloy known as German silver, which is composed of copper and zinc, whitened by the addition of nickel, and possessing all the distinguishing features usually associated with brass, except the yellow color. As the term is at present understood, however, it applies to an alloy consisting largely of zinc and tin, which melts at a comparatively low temperature and for many years was known as white metal, but which has been greatly improved and modified in recent years, until it stands in a class by itself. It is much in demand for bearings for automobiles and as a lining metal for bearings. A formula that can be recommended follows:

	Pounds.
Tin	55.50
Phosphor-tin	2.00
Antimony	1.50
Zinc	38.75
Copper	2.25

When preparing the alloy it will be found advisable to have the copper in the form of wire, sheets or ribbons, and to dissolve it in the zinc by melting a portion of the latter with the copper. Melt 20 pounds of zinc with the copper; and when it begins to flare, the copper will be dissolved. Stir well to be certain that the copper is dissolved, then gradually add the balance of the zinc, so as not to chill the molten metal. When all the zinc is melted add the antimony and a small piece of aluminum wire, possibly ¼ ounce, then add the tin and lastly the phosphor-tin, and pour into ingots.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

When brackets and flanges are molded vertically, some taper must be imparted, the amount of which increases with depth. This, by preventing bolt heads and nuts from taking a fair bearing all over, renders them liable to become wrenched off if tightened up hard. This is the reason why two devices are employed; arboring or facing, and the employment of small facings. When arboring is adopted, it often has to be done by hand after the parts have been fitted, and holes drilled and reamed. There is no objection to this when the holes are few in number, but when they are numerous, facings are preferable. The utility of facings lies in two directions; they may have less taper than the main flange or foot, or being of small area they can be tooled readily, either by arboring, planing or milling. In shallow brackets or flanges, the facings may go to the bottom of the flange, being then slightly oblong, with one end struck to a semi-circle, from the center of the square opening, Fig. 10. In deep brackets, they are fitted as circular facings, Fig. 11, in which case they have to be left loose in the mold.

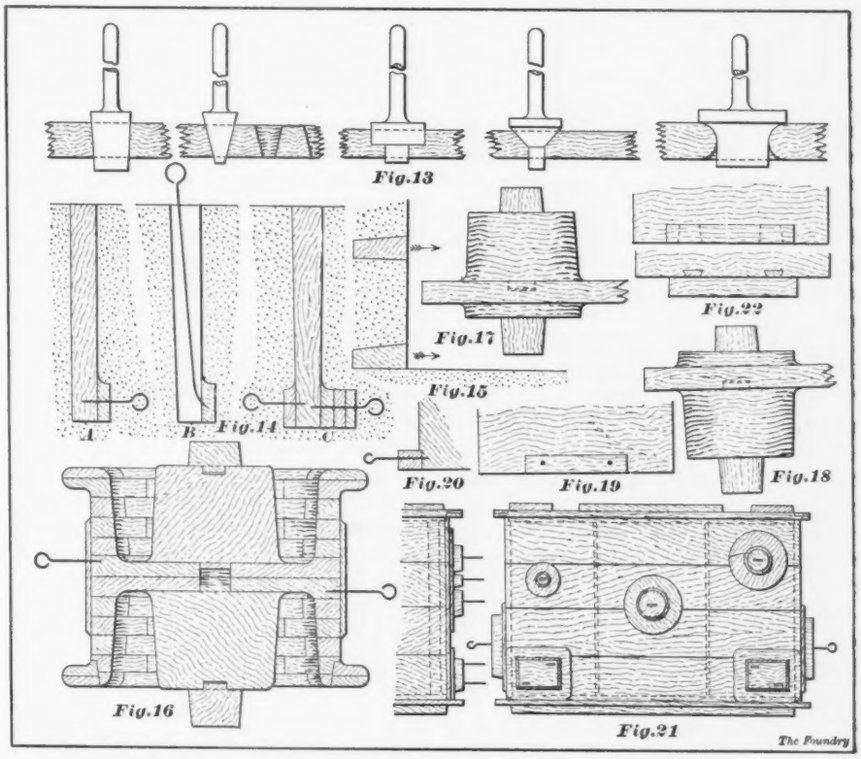
The illustration in Fig. 10 is a familiar one, being that of a tank plate in which arboring or planing would be out of the question. Here a very considerable amount of taper, often nearly ⅛ inch in the depth of a 2½-inch or 3-inch flange, is imparted, while the facing may have less than 1/32 inch. When the major portion of the flange is amply tapered, the facings need have scarcely any. The pattern in Fig. 10 is a rectangular iron frame, to which the wood flanges are screwed. The central part of the frame is strickled, and boards *A* are laid in to ram the top on.

Taper of Core Prints.

Another class of taper is that which is imparted to core prints which has proportions suited for prints only. It is always large in quantity, having no relation to the castings. It is better always to impart plenty of taper to these, and taper the core ends to match, than to run the risk of poorly tapered prints breaking up the sand, and of the exact location of the cores becoming altered by the process of mending up the broken mold.

The self-delivery of holes involves proportions of diameter to depth. The interior of a wheel or pulley rim is a hole in which little taper is required to insure a clean draw; but if the same taper were imparted to a hole of an inch or two in diameter the sand would be likely to be torn up. This is, therefore, a parallel case with that of the ribs noted in connection with Figs. 3 and 4. Small holes, special jobs excluded, are never made to deliver themselves, but cores are used. Exceptions occur in many metal patterns, and also in small hardwood patterns for brass work, and in some agricultural castings.

As a very general statement, it may be said that when the diameter and depth of a hole are about equal, the hole is able to deliver without a core print. But such holes require a slight amount of taper, the quantity depending on various circumstances, as on the way in which the pattern is made, finished and molded. In some holes any draught would be objectionable, while to some a large amount can be given without being objectionable in the casting. When holes deliver themselves, it is a general rule, as in prints, to give as much taper as the circumstances



of the case will permit. The fact to be emphasized, which entails the need of a considerable quantity of draught, is the small portion of green sand which forms the holes. The least unsteadiness in drawing suffices to fracture or detach this from the rest of the mold, even when it is assisted by a nail or nails. Square holes are worse in this respect than round ones, because sand sticks more readily in angles than on regular surfaces. Hence, it is much more troublesome to insure clean lifts in such cases with patterns drawn by hand, than in those drawn by machine. In plate molding, therefore, many such holes are made to deliver themselves which would be done with prints in ordinary hand molding. Illustrations of holes that will not, and holes that will deliver are given in Fig. 12, in which is shown three plates of different thicknesses pierced with holes, with dotted parallel lines in each case adjacent for comparison. In each case the holes, *A*, would not deliver, *B* would just do so and those marked *C* would deliver quite freely. If the patterns in which the holes occur were in metal, then the holes, *A*, might just withdraw.

Use of the Burning Iron.

When small holes are bored in wood patterns for self-delivery, they must be made exceptionally true and smooth. This is better done by burning than by sand-papering. A burning iron is better than anything; examples of various shapes are shown in the group, Fig. 13. The end is made red hot, and being thrust into the hole—rough-bored, or cut out with the gouge, it sears the surface of the wood instantly, making it smooth and almost impervious to moisture. The hole may be subsequently varnished if desired.

The question of the amount of taper arises in the case of loose pieces, considerable difference in the quantity imparted being entailed by variations in the location of the pieces. Pieces are fitted loosely for several reasons, but chiefly on the sides of patterns to avoid making a molder's joint with a corresponding middle part, or a drawback, or an awkward down-joint. Pieces are frequently left loose in the top, simply to enable them to be withdrawn from the top instead of lifting the top sand away from them. In this case, they would be dowelled, but when on the

sides, they are retained until partly rammed around by means of skewers, wires, or dovetails.

Loose Pieces.

It sometimes occurs that an absent-minded patternmaker locates loose pieces where they can only be withdrawn with much risk, or not at all. An individual strip must be considerably thinner than the space into which it is expected to be drawn. Neither should it be very deep down in a rib. The deeper it lies, the lighter it should be. The illustration, Fig. 14, graphically shows the reasons. The strip has to be drawn back, and taken up through the space of the rib or thickness, *A*, with the point of a venting wire, *B*. It must, therefore, be thin and light. Sometimes a strip is divided into two or even three thicknesses, as at *C*, but that is not very good practice, because when sand breaks so low in the mold, patching is troublesome. When the strip comes back into a large open space as in a mold which has to be cored, Fig. 15, then it may be of considerable width. Still, when flanges are very wide, loose pieces should not be used, but a joint made, either a main mold joint, or a drawback joint.

The proper place for loose pieces lies in those portions of patterns which can be easily drawn in. Here the question of coring over or of drawbacks never arises. The pattern in Fig. 21 is a good example. Its sides carry several loose pieces all skewered on, and having ample space into which they can be drawn, the interior of the casting being wholly cored.

The tread of the traveling crane wheel, Fig. 16, is turned, and is, therefore, cast to avoid turning up into the flanges. Such a pattern could be very well jointed through the middle, the halves going into bottom and top flasks. However, as that would involve leaving both flanges loose, the tread is skewered on loosely in four or six segmental pieces.

Pieces are often left loose in the top, as previously stated, for convenience of withdrawal only. That is done in the case of the deep top boss in Fig. 16. While a boss in the top of a pattern, such as Fig. 17, should be left loose, a shallow one, Fig. 18, is usually attached. Deep ribs, molded wholly in the top, are left loose, and if cross webs are in close contiguity, they must be loose even if shallow. Ribs may be attached when the interior space only is lifted in the top, as in Fig. 8, but then more taper should be imparted to them than to the bottom ribs.

Loose pieces are a frequent cause of wasters in the foundry, not simply because they have to be left loose, but because there is nothing very tangible to indicate their presence on, or omission from the pattern. Another reason is that they are often so fitted that they can be attached upside down, or end for end. The prevailing methods of attaching these pieces are either with skewers, wire nails, or dowels, the choice depending mainly on their location.

An example of a flange or foot attached with skewers to the body of a pattern is shown in Fig. 19. If the holes for the skewers are set a little out from an equi-distant position, it is easy to get the foot wrong by turning it end for end. If located at equal distances from the ends and centrally in relation to the edges, as shown, error cannot arise. However, if there is nothing but two small holes to indicate the fact that a loose piece is required, these may become filled up with sand or confounded with vent wire holes, and the loose piece may be forgotten or omitted altogether. This is not a hypothetical case, but one which is typical of a good many blunders which are made. Such errors can be prevented by making the holes equidistant from the ends and locating them centrally from the edges. Then if the loose piece is turned about, it will remain central, though the taper, if unequal, may be upside down; or, mark the position it should occupy by cutting a cross of a V with a chisel near one end of the piece, and another on the portion of the pattern with which its position should coincide. The presence of such a mark on the pattern shows the molder that a loose piece should go there. A line can also be drawn around the edges, on the pattern. Another plan is to cut a recess in the pattern just where the loose piece should go, and of the same size, Fig. 20; but this, of course, could only be adopted when the loose piece comes flush with the lower part of the pattern and would not be practicable when situated higher up. Another method, which applies to circular facings, bosses and prints is to put one skewer only in the exact center as in Fig. 21, where five facings with prints are thus skewered on. Each also may be scribed round, or crosses cut, or where there are several, letter stamps can be used. The oblong facings have two skewers each. The skewers can be inserted in these, as shown, so that turning about will not get them wrong, and they may be also stamped.

Dovetailing Loose Pieces.

Another, and the safest way of all, is to dovetail the loose piece on, Fig. 22, though this can only be adopted under the conditions shown. The taper of the dovetails permits the loose piece to remain in the mold after the removal of the main pattern, and the loose piece can only be fitted in one way.

Dovetails are also better than skewers for attaching loose pieces when they can be used, because they fit better, and retain the loose pieces exactly, and thus prevent mistakes. Skewer holes become enlarged with use, and loose pieces, slipping out of place, are not located correctly, and overlapping joints may occur. After the skewers are withdrawn, the loose pieces also may become shifted by subsequent ramming. Skewers are often located in awkward positions for withdrawal, flask bars, for example, being in the way. None of these objections applies to dovetails. In locating and setting loose pieces correctly, the dovetails have the advantage, because these can only fit one way, while with skewer holes the pieces may be turned about or even omitted altogether if the molder happens to overlook the holes. Dovetails are too obvious to be overlooked. Errors arise in loose pieces even when they are not omitted, due to their becoming rammed out of square, or askew. This cannot well happen with dovetailed pieces, but it does when broad pieces are simply attached with skewers. To prevent this risk, a molder should hold the piece up to its proper bedding, and tuck the sand around before commencing to ram. A plan frequently adopted is to secure such pieces temporarily with a wood screw, chalking round the head of the screw to indicate that it has to be withdrawn before the ramming is completed.

Porous Castings

Sponginess in castings, as usually experienced by the brass founder, is rarely cured by remelting, but is often accentuated. The spongy metal, when added to new stock in the crucible, will inoculate it and cause further sponginess, if some powerful and efficient deoxidizer is not added to remove the cause of the porosity. This is due to the fact that the trouble originates in the furnace in all cases when the cavities are large and are found in both the upper and lower parts of the castings. When this defect is due to pouring the alloy at too high a temperature, or when the mold is rammed a little too hard and also poured hot, the holes will exist in the cope side of the castings only, and will be generally found in flanges, etc., that rise up high in the mold. When such conditions prevail, the trouble may be corrected by remelting the castings and pouring at the proper heat, as the porosity is due to external causes and is not inherent in the metal, as is the case when it has been burned or oxidized in the furnace.

MOLDING BRANCH PIPES IN DRY SAND

Limited crane capacity, as well as the lack of skilled help, prevented the molding of these sections in loam

By Howard C. Deysher

AN ORDER was recently received for a number of 30 x 30-inch Y castings, which we decided to mold in dry sand, owing to the limited capacity of the crane, and the lack of skilled help. Therefore we were unable to follow the usual practice of making them in loam. The main portion of the pattern, *A*, Fig. 2, is cast iron, being a standard stock pattern, and the outlet is made of wood and built on to the iron portion, being parted in the center. The ribs are also of wood, and are cut at the joint line of the outlet. They are held in position on the iron portion of the pattern by two strips, one on either side of the pattern, which are let into the ribs.

Molding.

The method of molding is illustrated in Fig. 5, which is a vertical section of the mold, the parting of which runs on a straight line from *M* to *P*, and then at an angle to the middle of the outlet, *G*, Figs. 3 and 5. It will be noted that the drag is in sections for greater convenience in ramming the sand, and the lower or bell part is especially fitted for this class of work. The first operation in making the mold is to ram sand in the seat, *A*, Fig. 5, which is then struck off and slicked; the bell pattern, *B*, is then placed in position, the taper at the bottom of which is machined to fit the taper in the seat, *R R*. Parting sand is thrown onto the surface of the sand rammed in the seat, *A*, and the bottom flask, *C*, Fig. 5, is placed in position and brought central by two pins in the seat. It is then clamped and the bell is rammed. The main body of the pattern is next set on the bell, *B*, being properly located by means of the taper, *E*, which fits into a corresponding socket in the bell pattern. The first section of the flask, *A A*, Fig. 1, is then placed in position and clamped, and the bottom half of the outlet is set against the main pattern and fastened in the proper position. The mold is then rammed up to the line of the first rib, which is then placed in posltion and secured by screws from the inside of the outlet, and by strips hanging on each side of the main pattern, as previously stated. The sections *B* and *C*, Fig. 1, are next successively placed in position and rammed with sand, and the drag parting is made. The cope half of the outlet is then placed in position, closed over, clamped, and the ramming completed. An iron bead ring, *F*, Fig. 5, is bedded on top of the mold to form a seat or print for the covering core. The main pattern is next drawn out, the cope lifted off and supported on horses, the screws are taken out of the ribs, and the outlet pattern drawn from both cope and drag. The ribs are allowed to remain in the mold to facilitate the location and lining of the bolt hole prints.

The drag half of the mold at this stage is shown in Fig. 3, with the cope in the background.

To strengthen the casting, three 2-inch bolts are passed through it. Holes must be cored in, 2⅛ inches in diameter, and in order to get them in line, and avoid machine work, the prints and anchors are set in the following manner: Through each rib of the pattern in the center of the boss, a 2¼-inch hole is bored and the circular openings, *A A*, Fig. 3, are provided in the flask, so that their centers are in line with the holes in the ribs. A pole, 2 3/16 inches in diameter and sufficiently long to reach across the flask, is next utilized. This is pushed through the wall of sand in the flask opening, and through the hole in the rib to the opposite rib and port hole. The pole is then withdrawn and the prints rammed in, this method being followed on each set of ribs. After the rib patterns are withdrawn and the mold dressed, the pole is again inserted on one side, and two anchors are slipped over from the inside of the mold, the pole being then pushed into the print on the opposite side. An anchor is then set in the boss of each rib and the pole withdrawn, the same operation being repeated on each rib. The mold is then blacked and run into the oven to dry.

The main core is built on a spindle, hay rope being used, and two coats of

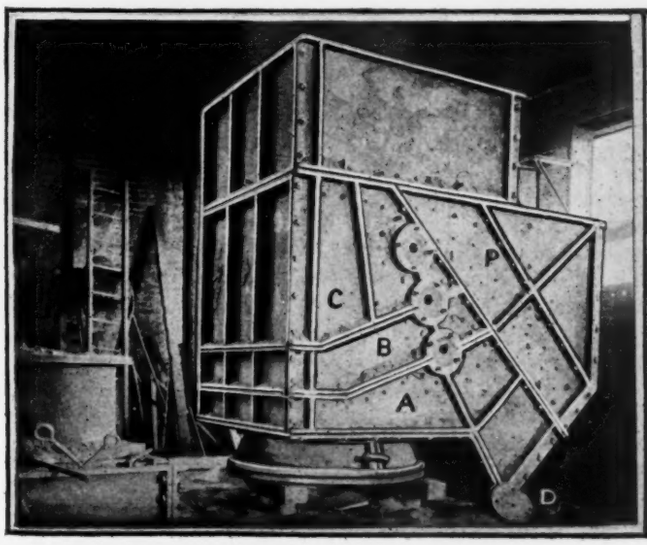


FIG. 1—THE ASSEMBLED MOLD, SHOWING THE FLASK SECTIONS AND UNCOVERED PORT HOLES

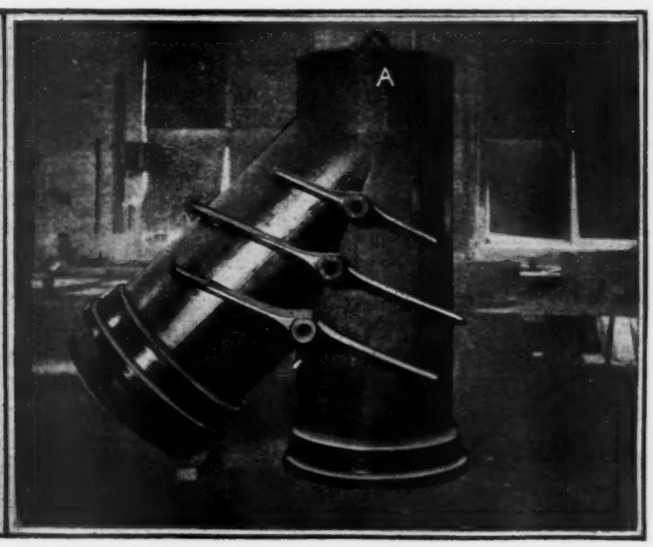


FIG. 2—THE BUILT-UP PATTERN, SHOWING THE POSITION OF STRENGTHENING RIBS AND LOCATION OF BOLT HOLES

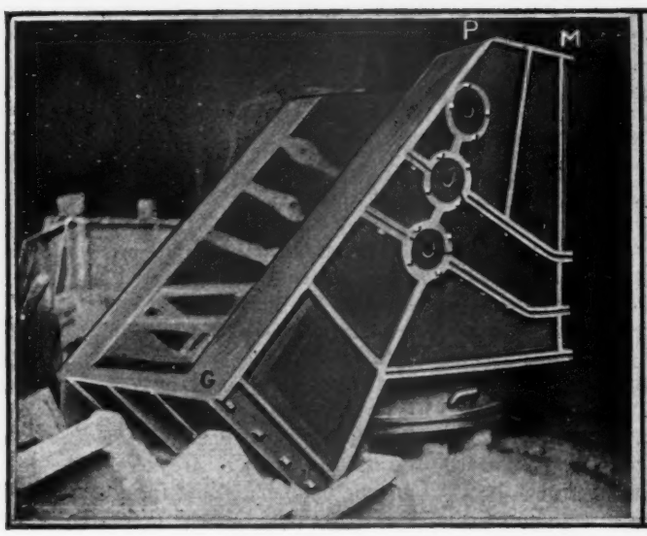


FIG. 3—DRAG SECTION OF MOLD, SHOWING THE JOINT AND RAMMED-UP PORT HOLES, WITH BOLT CORE PRINTS IN THE CENTER

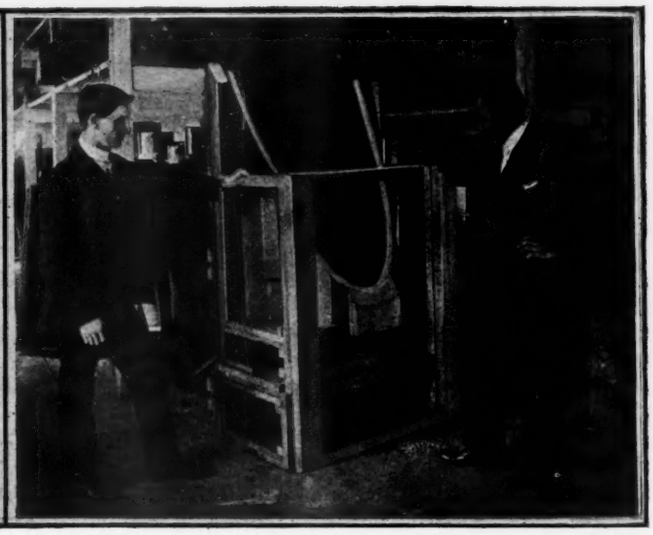


FIG. 4—CORE BOX, IN WHICH THE OUTLET CORE IS MADE

mud are applied. The core is partially dried and blacked, after which it is thoroughly dried. The outlet cores are made in a box, Fig. 4, each half being closed on the joint with a board, which is doweled and secured to the box with hooks. The end of the box and the board are cut to fit the main core. The core is rammed up, resting on the bell end, and the curve to fit the main core is swept out with a plain strike. The joint board is then removed, a plate clamped on, and the box lifted off. Lifting hooks are placed in the joint of the drag half, and on top of the cope half of the core. The socket cores are built on an iron ring, *S*, Fig. 5, which is machined to receive the main core, a section of which is shown at *T T*, and illustrates how the core fits into the tapered seat in the ring. The covering core is made in a ring box and is turned out on a plate and dried.

When coring the mold, the main core is first set; while the cope is in position on the drag, the former is lifted off, the position of the main core at the joint noted, and the outlet core is set. Sand is rammed between the end of the outlet and the flask to keep it in position, an opening being left for the vent. The ring core fits snugly over the main core, and rests in its print, so as to hold the main core central in the mold. Openings are provided in the ring core for the entrance of the iron. The bolt cores are pushed into the mold and against the main core from the outside of the flask, the port holes in the latter being closed by bolting on the circular plates, *D*, Fig. 1.

The casting was made about 4 inches longer than required, the extra length being cut off in the machine shop. The mold was cored in the pit, the flask being well braced to overcome the strain of the iron. All of the castings molded in this manner passed inspection.

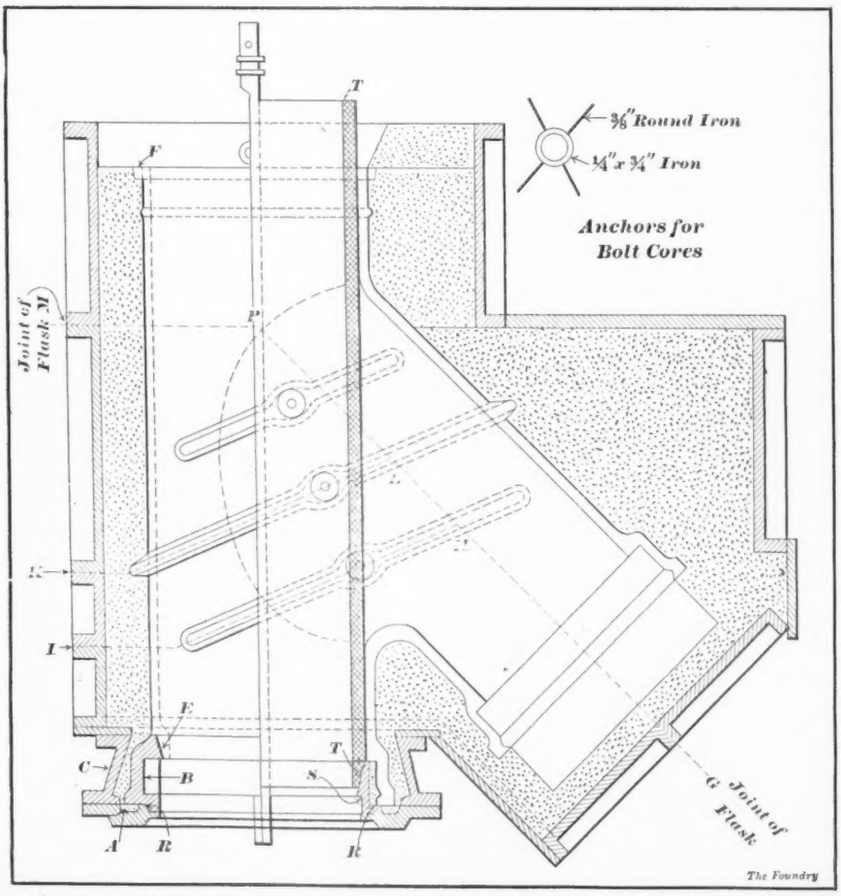


FIG. 5—VERTICAL SECTION OF MOLD, SHOWING ITS CONSTRUCTION AND METHOD OF CENTERING THE CORE

Brass Couplings

Question:—We would like a formula for a red metal for couplings, that will machine easily and that can be stretched. We make them in both red and yellow brass, and it is only with the former that we have trouble.

Answer:—Try the following alloy: Copper 87 per cent, zinc 8 per cent, tin 3 per cent, lead 2 per cent.

INSPECTING IRON AND STEEL CASTINGS*

The work of the inspector in the foundry and how his duties may be facilitated by co-operation with the foundryman

By J. A. Gearhart

THE inspection of castings, from the standpoint of the inspector, covers, in the main, just two conditions, good or bad castings. In other words, they are good enough for the service intended, or they are unfit for this service and should be rejected; but in the actual inspection of the work at the foundries, to arrive at these two conditions, considerable responsibility rests on the inspector. He must be able to distinguish a real defect from a slight flaw; he must be able to decide whether a defect, when found, is of sufficient importance to affect the strength or wearing qualities of the casting, or if it is in a part not subject to strain in service and will, therefore, answer the purpose for which it was designed.

Information for the Inspector.

To inspect castings and be just and fair to both employer and manufacturer, an inspector must know the exact location where the casting is to be used, what its functions are in service, and all other information it is possible for him to obtain, so that he will be competent to decide whether it is good or bad. In checking to dimensions on prints he must know how close to drawing sizes the casting must be in all parts so that it will fit in the place for which it is designed, as it is well known that castings of the same design and made from the same pattern are not always exactly of the same measurements in all their dimensions due to the variations in different heats or casts, as well as differences in the molding and a dozen other variations too numerous to mention.

Variations in Size.

There are some dimensions where ¼ inch variation can be allowed, either above or below the given size, while on other dimensions 1/16 inch allowance, either way, is too great; some surfaces must be straight and parallel with others so that clearances at other points may be maintained; while other surfaces must be at right angles so that certain points will have equal wear in service.

An inspector must know what pockets are to be cleaned, what corners are to be chipped square, what corners a fillet can be allowed and the largest radii permissible on any fillet. On castings of intricate design, where there are unequal shrinkages, the inspector must know when the manufacturer has cast these with shrinkage brackets to overcome any checking. He must know whether it will be necessary to chip these brackets to the original contour, or if the shrinkage brackets may be left on and the castings accepted. The inspector must know, when he finds a shrinkage crack, if it is of sufficient cause for rejection or if the casting is as good for the purpose intended as one on which no cracks appear. An experienced inspector will generally know, from the shape of the casting and the method of molding, where the shrinkage cracks or blow-holes are most likely to occur. An inspector who knows where and how his castings will be used will save considerable money for the foundryman, as well as time on the delivery of the work for his employer.

Repairing Defects by Welding.

At the present time, with the different welding appliances used so extensively in steel foundries, it is a question when the inspector finds a casting has been welded whether to accept or reject it, as he has no means of telling how serious the defect was before it was welded. I know of one concern that objected at one time to the welding of any part of its castings, and any castings showing the least indication of welding were rejected at once. Some foundrymen, who had contracts to furnish castings to this company, did all the welding that they required before annealing, after which the surface was ground or chipped smooth and then thoroughly annealed. The castings, when offered to the inspector, were coated with a heavy scale. It was very difficult to tell in these cases if the castings were welded or not. Differences of opinion arose between the manufacturers and the inspectors until so many castings were involved that shipments were seriously delayed and the company needed the castings.

This concern now specifies that all castings to be welded must be first shown to the inspector, and if in his judgment the defect will not affect the strength or wearing qualities and the welding will improve the appearance, he stamps the casting with his private mark near the defect but not close enough to be obliterated in the welding. After the welding has been finished the casting is again shown to the inspector, and if done in a workmanlike manner, is then accepted and restamped near the trade mark or pattern number. This method has worked very successfully and in my opinion is fair to both parties.

Co-operation of the Inspector.

It has been the author's experience that the best results have been obtained on orders subject to inspection, when the manufacturer and the inspector went over the drawings together so that important dimensions were fully understood and could be watched by the manufacturer in making the patterns as well as in molding and casting. This plan, if followed, will generally save the foundryman considerable money as well as time in completing a contract.

When an order is placed, subject to inspection, and when the first shipment is ready to go forward, a request is sent for the inspector. On his arrival the manufacturer finds for the first time that the castings must fit certain gages on which very small limits of variation are allowed. This generally necessitates the return of the castings to the grinding or chipping room to be made to fit these gages, but in some cases it means their rejection, as they cannot, in their present condition, be made to fit the gages to the satisfaction of the inspector. This could have been avoided if the manufacturer and inspector had conferred together before the work was started and everything gone over and explained. The manufacturer would then have known about the important points on each casting and could have governed the work accordingly when making the patterns, as well as when issuing the necessary instructions to the different departments. I have found that both expense and trouble have been saved by following this plan, but I do not

*Read at the October meeting of the Pittsburg Foundrymen's Association.

wish to convey the idea that the manufacturer should request the inspector to check patterns.

The inspector should be glad of an opportunity to check sample castings, but never to check patterns, as he is not familiar with the shrinkages of the metal, nor the methods of molding at any one plant, as he is interested only in the finished product.

Gaging Patterns.

An instance that comes to mind concerns two castings, the one fitting into the other when in service. The top casting was made by one firm while the bottom casting was made by another. Both manufacturers were notified that the castings must fit certain gages and must come within certain limits. The sample casting for the top was made and found to agree with the gage. When the sample casting for the bottom was made it was found too small to allow the gage to enter. The manufacturer showed the inspector an order for 500 castings of the same design that had just been completed. They had been inspected and accepted, but had not been gaged. The patterns had not yet been taken from the sand and were then running on this order. As no objection had been raised by the parties assembling the 500 castings, it was assumed that the castings were being fitted without any trouble and therefore, there was no reason for changing the patterns to agree with these gages. It was conceded by the foundryman that the measurements were a little under the blue print size. The difference was about 3/32 inch in a length of 12 or 15 inches, but this was so small in his opinion that no trouble would be experienced. When it was explained by the inspector that all castings of that design must fit the required gages so as to allow castings from different foundries to be assembled, and all be standard, it was finally agreed that one or two patterns would be changed so that castings to be shipped on this inspector's order would fit the gages and be acceptable to him. The manager and inspector then returned to the office, where a telegram was awaiting the manager advising him that the 500 castings shipped on the previous order could not be used as they were too small in the dimensions covered by the gage. It is needless to say that orders were immediately given to change all patterns to agree with the inspector's gage, and a duplicate gage was made for the foundry to avoid any similar mistakes in the future.

The drawings should be made to show clearly every detail necessary to guide the manufacturer in producing a casting as well as for the information of the inspector. Often it is necessary to show the use of a particular part, as for instance, in making a type of cast steel box form bolster, ¾ inch holes were shown. The inspector found the shop busy reaming these holes to an exact ¾ inch. They were drain holes only, and should have been so marked on the drawing.

When castings are made to specifications prescribing test coupons for physical tests, especially in cast steel work, the inspector should see that these coupons represent truly the casting from which they were taken, and that they have not been given any additional reatment either by hammering, annealing or other wise. It is common practice for most inspectors to have a hammer with private mark for stamping coupons and accepted castings, but the inspector should use judgment in the different shops, in the method of handling the test coupons after they have been selected and stamped.

Test Coupons on Steel Castings.

Specifications covering steel castings, in all cases, require that test coupons must be cast on the castings and broken off in the presence of the inspector. It is important to know on what part of the casting and the manner in which this coupon is attached to the casting, so that the results obtained will fairly represent the material. I have in mind castings weighing 15 tons each that had coupons attached, made by the molder pressing a round stick in the bottom of the drag after the pattern was drawn and the mold ready to close. This stick was 1½ inches in diameter and was pressed about 4 inches in the sand at right angles to the casting, and no allowance was made for the gas to escape. The mold was gated at the bottom and the metal running over the bottom of the mold had pushed all the dirt and loose sand down these holes.

Tests and analyses made from these coupons did not represent the material in these castings. Very few bars were found without flaws and other test pieces selected from the runner of the gate and from the castings taken with a hollow drill did not agree either in physical tests or chemical composition with the results obtained from the test coupons.

The inspection of steel castings calls for the most careful work on the part of an inspector as it is exceedingly difficult to distinguish between a mere blemish and a real defect. One casting will be spongy and porous on the surface but all holes will be small and shallow and will not affect its strength, while another casting will, to all appearances, have a smooth surface with the exception of a few small holes, which, when explored, will increase in width and volume with the depth, and the casting will be found to be only a shell.

Blow-Holes.

The volume or area of blow-holes is often determined by the amount of water the cavity will hold. This test is an old one and it would be well to caution the inspector before making this test to be certain that the cavity has not been filled previous to testing.

A number of years ago a workman in a foundry, appreciating the prying curiosity of the inspector, filled the blow-holes with hot wax to nearly the top of the surface and when tried with water, the inspector found only a shallow cavity. In another case a workman was found busily filling shrinkage cracks in the fillet of a large steel casting with a metallic substance, which was put in the crack in a soft condition. The crack was filled to the surface and burnt sand was rammed as a top dressing. The result was, indeed, a work of art. These methods and many others were used a number of years ago to have castings accepted by the inspector, but it has been found cheaper and better for all concerned to so improve shop methods that defective castings will be reduced to a minimum.

In another instance a specification rigidly prescribed a mixture of certain pig irons, scrap, etc. The inspector always arrived at the shop at a certain time and, unknown to him, his entrance at the gate was always announced to the charging gang; he generally proceeded immediately to the charging floor, where he found a number of buggies loaded with the prescribed mixture—a certain percentage of charcoal iron, coke iron, scrap, etc.—and while he was present one or two of these loads were dumped into the cupola. This seemed to satisfy him, and he would proceed to other parts of the shop. The buggies charged while he was on the floor were all that were charged each day of that specified mixture, the others were held for his visit the next day, and the work proceeded ac-

cording to the personal theories of the foreman.

Inspecting Brass Castings.

When inspecting brass or bronze castings, aside from the tests and analyses specified, the inspector should break a few castings from each day's work. This will enable him to obtain an idea of the structure of the material and it will give him an idea of how well the metals have been mixed. Any segregation, or soft and porous spots, will be detected, which is important in castings used for bearings, as any segregation generally develops a hard spot, while soft or porous spots act as a catch-all for dirt, causing unequal wear or hot journals.

On brass or bronze castings used for interior decorations it is necessary to pay particular attention to the color of the metal so that it is uniform. On one order for racks and fixtures used on cars the mixture was specified so as to insure a certain shade. On some of the fixtures the castings were to be brazed with rolled metal. Orders were placed with three different makers, two of them succeeded in purchasing rolled material similar in color to the castings, but the third depended upon using yellow brass, which he plated and expected to obtain the desired shade. The inspector had been furnished with a sample piece of the composition and color desired. As each strip of rolled material had been separately plated, a difference was noted immediately.

Inspection of Iron Castings.

On iron castings, particular attention must be paid to the thickness of sections. These are generally designed for a certain pressure, as pipe and pipe fittings, or to bear certain loads, as car wheels, etc. The thicknesses of sections and walls have been worked out when the castings were designed to give the desired strength with a certain pressure or load. Any deviation in these thicknesses, especially on the low side, is apt to cause a failure in service and is not what the purchaser pays for, nor has a reasonable right to expect. On a large casting, it is the best practice for the inspector to be at the foundry when the mold is closed and to witness the pouring.

A few years ago I saw the base of a steam hammer that had broken in service. It weighed approximately 10 tons and had been in use about four months. The failure was due to the fact that the center of the mold had been filled with bolts, nuts, washers and other scrap, which had been anchored in the mold in some manner that held this material central while the mold was filled with the molten iron. From outward appearances the casting was solid.

In the matter of tests, these are generally covered by the specifications, and it is the inspector's duty to know that the tests he selects are as nearly representative of the material in the castings, as it is possible for him to obtain.

The Inspector.

An inspector should be amiable, have good sense mixed with sound judgment, and be a gentleman at all times. I have known instances where castings, with small defects, were rejected and thrown aside by workmen without asking the inspector to pass upon them, because he was well liked in the shop, and the employes would not offer castings to him which they considered doubtful. In other cases, when the inspector has not been so agreeable, every casting was offered to him and the work of inspection made as hard as possible.

There is no question but that it is the manufacturer's right to decide the manner in which the castings are to be made, but it is also the right of the inspector to pass upon the castings after they are finished, and it is his judgment that must decide whether they meet requirements, and are good enough for the purpose intended. By getting together before an order is commenced, or by making a few sample castings, much annoyance, for both the manufacturer and the inspector, can generally be avoided.

When the mixture has not been specified in the contract the manufacturer has the right to decide the kind of material to use in making his steel, iron or bronze and the process of manufacture, but the inspector must decide whether the castings are of the grade of material desired, and if they meet the specifications under which they were purchased.

Slow Melting

By W. J. Keep

Question:—Our cupola seems to be a very slow melting medium. It is 30 inches inside the lining and has a height of 84 inches from the bottom of the tuyeres to the charging door and the height from the top of the bed to the bottom of the tuyeres is 10 inches. We use 10 bushels of coke on the bed and charge 700 pounds of iron and scrap with a bushel and one-half of coke. All of the charges are uniform. Our heats average from 6,000 to 7,000 pounds of iron and we would like to know whether this is beyond the capacity of the cupola. The iron is hot to the sixth or seventh charge and then seems to cool. We have had no slag hole until recently. Kindly advise us what you consider the best method of operating this cupola and how much limestone to use.

Answer:—You are using 350 pounds of coke on your bed and 50 pounds on each succeeding charge. If you melt 7,000 pounds of iron, you have a total of ten charges and the last four charges are dull. Your cupola is capable of melting more than 7,000 pounds of iron if you can keep the slag running hot more than two hours before you expect iron to come down. When the coke is well ignited, ascertain how high the bed is in your cupola. It should be 15 inches above the top of the tuyeres, and if it is not this height, add more coke and then begin charging. Use a measure for your coke which will contain 55 pounds when filled, and if the iron still continues dull, make it 60 pounds. Your present melting figures, 7,000 pounds of iron melted with 800 pounds of coke, or a melting ratio of 8¾ to 1, are altogether too low for so small a cupola. I would suggest that you add 10 pounds of coke to the bed and 10 pounds to each charge, making the bed 360 pounds and each charge 60 pounds. You will then be melting at a ratio of 7½ to 1, which is also too high for a 30-inch cupola, but from your past experience you should obtain this result. The trouble is that you do not replenish the bed enough with each charge. If you are obliged to use 70 pounds of coke for each charge of 700 pounds of iron, your practice will be considered good. As rapidity of melting results from the time that it takes to burn enough coke to melt the iron, increasing the coke charge should make the melting slower. If you have made your iron uniformly hot, increase the air supply by increasing your blast and also increase the number of your tuyeres. A gage should show at least 7 ounces of blast pressure and 10 to 14 ounces would prove more satisfactory. When you have done this, you can probably cut 5 pounds of coke from each charge and you will obtain quick and rapid melting. Use about 10 pounds of good limestone to each charge of coke, and if the slag does not run fluid, add more limestone. If the charging door were 2 feet higher, better results could be obtained.

THE UTILITY OF THE SKELETON PATTERN

Making a skeleton model of a centrifugal pump casting---Cheap method of making pattern plates

By J. R. Moorhouse

POSSIBLY in no other branch of foundry work is it more essential for the molder and patternmaker to work hand in hand than on skeleton patterns. The scope of skeleton patterns is unlimited and the saving effected in many instances is considerable, especially with certain lines of pipe work. Usually, an inferior kind of lumber can be used. Skeleton patterns outline and contain directions, which the molder is expected to follow, as the nature of the work may demand, and upon his skill and judgment the accuracy and appearance of the finished casting largely depends. In many cases it is possible to finish the mold entirely by sweeps and strickles, supported on timbered sections, and castings so formed leave little to be desired as to appearance.

Skeleton Pattern of Centrifugal Pump Casing.

Fig. 1 illustrates a large centrifugal pump casing, with the core box in the background. There was quite a saving in the amount of timber used in addition to the patternmaker's time in the construction of the pattern. This was offset to some extent in the foundry as the molders were expected to complete the pattern by filling in with sand, all intervening spaces, and they were compelled to space the ribs as uniformly as possible. The question is here raised, will the balance of the difference by the saving effected in the pattern department, against the added expense of the foundry department, warrant the use of a skeleton? If the margin is small, the writer would favor the full pattern for the following three reasons:

1.—More risk attaches to the molding from a skeleton in consequence of the rough and uneven surface, so that when a cope is lifted, where the shaft is deep and square, it cannot be parted as easily as with a full finished pattern.

2.—Usually, castings produced from skeleton patterns have not that uniform and even appearance as those cast from a full pattern, and are not so accurate.

3.—In case of a possible mishap, or a repeat order, the pattern is already at hand and is the more convenient one to use.

Methods of Making Skeleton Patterns.

Various ways and means are adopted in the construction of skeleton patterns. For large pipe bends and connections, it is common to make both the internal and external diameters by the one pattern point, no core box being required. The layout is first made, and upon this strips are built up of a width equal to the metal thickness, and of a depth that will insure the stiffness of the pattern. One set is required for the drag and one for the cope. These are doweled together and give the outline of the pipe at the joint of the mold. The end flanges are then built-up, and temporarily screwed to the layout as parted through the joint of the pattern. Secured and lapped into these flanges are the strips above mentioned, with the addition of another strip at the top of the half circle. Where the pipe is very large, a greater number of strips may be used, evenly spaced between the two strips at the joint and the strip at the top half of the circle. Circular ribs are now made and lapped into the strips. The number and distance between ribs depends upon the size of the pattern under construction. Any additional flanges, bosses, brackets, etc., that need attaching to the pattern, are located and screwed from the inside of the pipe, if the drag half is first constructed. This is accurately and easily accomplished by squaring up from the layout the various positions they are to occupy.

The drag half, when completed, is removed from the layout, turned over, and upon this is placed the joint strips of the cope part, these being secured by the end flanges in the same way as for the drag, and completed in the manner above described, with the exception that all ribs, etc., are screwed and secured from the outside, so that as the cope part is being rammed, these may be loose and insure their coming up into the cope when it be lifted from off the pattern. Usually, the pattern is bedded-in the foundry floor. A sweep to place between the ribs is necessary to form the outside mold. Parting sand is strewn over the mold, and the spaces between the ribs filled in with sand, which leaves the pattern as a core box in which is rammed the core. But, previous to this, all ribs, etc., have been

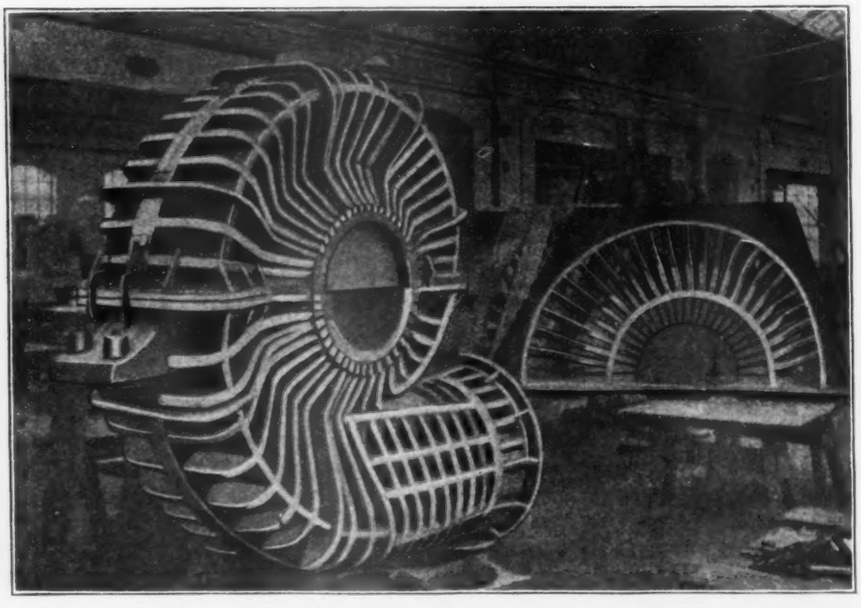


FIG. 1—SKELETON PATTERNS AND CORE BOX FOR CYLINDRICAL PUMP CASTING

unscrewed to prevent their separate removal.

Making the Cope.

The cope being completed, the cope part of the pattern has the ribs likewise filled in, upon which is strewn parting sand, and the cope is rammed upon it. When this is completed and the cope removed, the cope half of the pattern is raised to allow the core to be drawn from the mold, to be dried. The drag part of pattern is then removed and finished, and the procedure of closing the mold and casting is the same as though a full pattern with a core box were used. In principle, most all shapes and sizes can be economically produced in this manner. As to other descriptions of skeleton work, there is a wide variety. The writer has seen quite a number of castings of a pump casing, when there has only been a skeleton core box provided, from which the core was made, and from this in turn the pattern by rolling out clay thickness strips, which were placed all over the core. After the drag and cope were

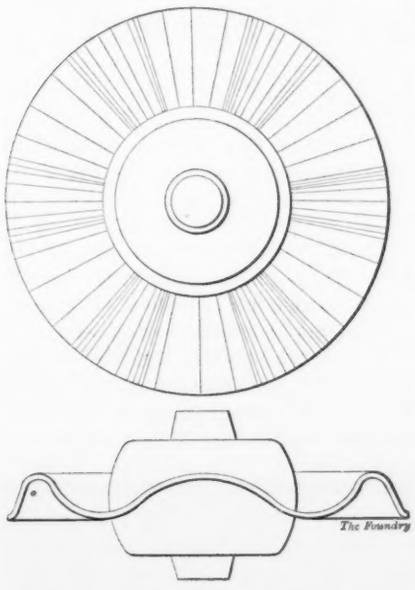


FIG. 2—PLAN AND SIDE ELEVATION OF PATTERN TO BE MOLDED ON A MOLDING MACHINE

made, these clay strips were removed, and the core placed in position, leaving an even thickness of metal throughout the whole mold.

Patterns for Automobile Work.

We have in the construction of automobile patterns what may be said to be the most expensive and highly finished work of the craft. The desire to have all castings as light as possible, consistent with strength, and the fact that jigs are used in the finishing of such castings, entails accurate construction in all patterns related to the automobile industry. Such loose pieces as bosses and webs should be practically secure when in place,

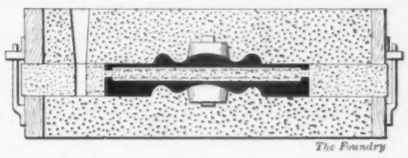


FIG. 3—CROSS-SECTION OF THE MOLD CONTAINING THE TWO PATTERN PLATES

at the same time they should permit of the pattern being easily drawn from the mold. In place of a removal dowel, that is a dowel securing some boss or bracket to the body of the pattern, which it is necessary for the molder to remove, previous to completing the ramming of the mold, it is advisable to use a dovetail where possible, as frequently a boss is vital in the facing up of the casting in the jig; and where this is out of place everything else comes relatively with it. A boss being torn from the body of the pattern before the mold is complete, may by various reasons, get a little out of place. With dovetails, everything is secure until the pattern body is drawn from the mold. Special attention should also be given to the selection of lumber. It should be thoroughly seasoned, and the pattern should be built in such a manner as will insure it against warping and distortion from the moisture and heat of the foundry. It is to be understood that only the best class of work in this particular branch of the craft will mean economy in the end.

Lumber.

Mahogany and red cedar are about the best grades of lumber to use, being less liable to warp, and will hold up to size better than any other kind of timber. Cherry is also good, especially for core boxes, as it will stand the pounding better than other kinds, mahogany sections being substituted where intricate carving is necessary. In cases where overhanging brackets and projections are liable to be knocked, strained or scarred by ramming, it is well to protect them by metal sections.

Aluminum Patterns.

Aluminum is one of the best metals for this purpose on account of its lightness. When these sections are made of other metal heavier than aluminum, they soon work loose on account of the continual ramming and rapping of the pattern. Loose ribs, etc., are also best made of metal. Many patterns are now mounted on molding machines, and they insure a more accurate casting with very little variation in shape and size. Therefore, they are the more easily set up with jigs, than castings obtained from patterns drawn by hand. The importance of having castings alike cannot be too strongly emphasized. The writer has seen more than 50 manganese bronze gear cases condemned on one order because of the various irregularities in these castings not showing in the pattern.

In finishing patterns the use of cheap varnish is to be deprecated. Three coats should be applied, which usually insure a coating impervious to the moisture of the sand. If patterns are made from cast iron, a coating of a solution of bay-berry wax dissolved in benzine will be a preventive against rust and will leave a smooth finish on the pattern.

Patterns for Molding Machines.

The extensive use of molding ma-

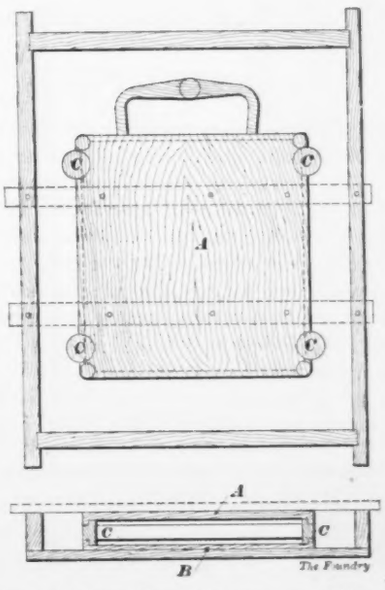


FIG. 4—CORE BOX FRAME, IN WHICH THE PATTERN PLATES ARE MOUNTED

chines has brought the metal patternmaker more in touch with the principles of the molders' art than heretofore. There are many machines now on the market capable of doing very complicated work, and judging from castings made on these machines, the metal patternmaker has had quite a few stiff propositions to overcome. For molding machines doing average work, omitting the higher grade, such as art work or small intricate machinery castings, cast iron is exten-

sively used for the plates. These are planed and patterns located upon them with gates attached, so as to leave little or nothing for the machine operator to finish on his mold. On some types of machines, cope and drag plates are required.

Cheap Method of Making Pattern Plates.

The following method is a cheap way of producing these plates for an average shallow draft class of work. Fig. 2 shows the casting to be made. A flask is chosen with extra long pins, in this case 4 inches. A frame core box is then made of a size a trifle larger than the flask. In this are located two pattern plates, *A* and *B*, Fig. 4. These plates are of standard size and about ⅜ inch in thickness below the joint. The runners are located with the pieces, *C C C C*. The core being finished, the pattern is molded, placing it in such a position that it will come in the desired relation with the plates formed on the core. This pattern is molded and gated in the ordinary way. The drag is then covered with the core, as shown in Fig. 3. The runner is cut through the cope to coincide with the runner in the core. When the mold is closed the two plates are held together by the four pieces *C C C C*. After being drilled, the plates are separated and filed and finished in the ordinary way, with the result, that instead of a single plate having drag on one side and cope on the other, we have two independent plates that may be worked separately. This system can be extended to a large class of work.

For general metal pattern work, aluminum is now preferred. The chief advantage of this metal is its extreme lightness, a feature enjoyed by the molder in that he has more control in drawing the pattern from the mold than if the pattern were made of a heavier metal. Patterns carded with this metal are less liable to break off at the gates, as the constant jar, when heavier metals are used, frequently cause a fracture in the thinner portions of the pattern. Aluminum patterns can be relied upon to keep their size and shape under average working conditions, and the metal can be easily filed and finished. The shrinkage will average about 3/16 inch per foot.

Bronze Patterns.

For very accurate work, bronze is the best metal to use, but the most expensive. This, no doubt, is more than compensated by the results obtained, as no better metal can be desired from the molder's point of view. Patterns, so made, leave the sand very readily. The shrinkage is about 3/16 inch per foot. White metal patterns are least desirable, as they are very unsatisfactory when compared with the aluminum and bronze. Where a divided frame is used, worked by a vibrator, a card will hold together much longer than if wrapped by hand, with the additional advantage of more uniform castings.

A Crucible Steel Foundry in the Northwest

By Louis P. Zimmerman

IN THE country west of the Rocky Mountains and north of Stockton, Cal., there is only one crucible steel casting plant in operation. The Portland Bronze & Crucible Steel Foundry, Portland, Ore., is the pioneer concern in this line of steel casting manufacture. Beginning in a small way in 1907 this foundry is prepared to make crucible steel castings from 1 to 200 pounds in weight. The trade demand for crucible steel castings covers a wide range in this shop, including everything from automobile crank shafts and gears to saw mill specialties, the latter comprising the bulk of the work.

Crucible Steel Foundry.

The foundry building is 40 x 60 feet, one story high, well-lighted and well-arranged. All machinery in the foundry is motor-driven. A 6 x 10-foot core oven is built in the outside wall and is fired by an outside furnace burning 4-foot slab wood, a saw mill waste very cheap locally. The melting furnace is placed alongside the core room and is built so that the top is flush with the foundry floor. Crude oil, supplied by a gravity system is utilized for fuel. An oil storage of 1,500 barrels is provided in two tanks, oil being pumped from the outside storage tank to the elevated pressure tank. The overflow pan

FIG. 1—A SECTION OF THE MOLDING FLOOR OF THE PORTLAND BRONZE & CRUCIBLE STEEL FOUNDRY CO.'S PLANT

FIG. 2—THE CRUCIBLE OIL MELTING FURNACE, GRAVITY FEED, OVERFLOW PAN SYSTEM

system is used in firing. There are two rows of pans with two pans in each, placed one above the other. A baffle wall deflects the heat downward through an entrance at the bottom of the furnace. Eight 100-pound crucibles can be heated simultaneously. Crucibles are handled in and out of the furnace with long-handled crucible tongs provided with a block and cable for lifting out.

Scarcity of Sand.

Boiler plate punchings varying in size up to 3 inches are used for charging. These punchings cost from $10 to $13 a ton. Contrary to general practice, a disk skimmer is used for removing the slag from the crucibles, instead of a rake-off. Silica sand for molding is shipped from Illinois and costs about $13 per ton delivered locally. The question of silica sand and molding sand is becoming an important one on the Pacific coast. Due to the peculiar formations on this coast, there is very little available silica and molding sand that has so far been found. A number of iron and steel foundries are carrying on extensive investigations to locate sand of good quality for foundry purposes. Most of the sand found on the coast carries a very high percentage of vegetable matter with it, which causes it to burn out quickly. Some of the available molding sand has a very large percentage of clay and dirt mixed with it, so that it must be run through a washer before it can be used. Practically the only silica sand that has been found is a deposit near Monterey, Cal. This was tried out by the Columbia Steel Co. and Portland Bronze & Crucible Steel Foundry and proved unsatisfactory. This sand contains a high percentage of lime, which causes it to stick to the castings and prevents them peeling clean.

Flask Equipment.

Storage for all but the very largest flasks is provided within the foundry. Wooden flasks, iron flasks, and combination wood and iron are used. For large work and for special work that will not be duplicated, wooden flasks are used. All small flasks are iron, being used two part or three part as desired. A feature of the 12-inch square standard iron flasks is the 1½-inch extensions which can be used on either side to build up the height of the flask as much as desired. These extensions have a lug cast in each corner to secure them to the flask and prevent slipping when rolling over. They are found very useful in the general jobbing work handled by this foundry where a great variety of forms and size of patterns comprise a week's work.

Castings from this plant cover everything from crank shafts to sheaves, as well as saw-mill equipment. All work is done by day labor. No molding machines are used. Small work is worked on benches and large work on the molding floor. The officers of the company are: Leonard Schad, president; C. W. Schad, vice president, and J. A. Moe, secretary and treasurer. A feature of the plant is the chemical laboratory. This is noteworthy for a small foundry, as very few plants of any size in the Northwest have a laboratory, though the majority are now beginning to use chemical analysis in determining their mixtures and are buying their iron on specification.

The Preparation of Coke Samples

By W. S. Ireland

MANY foundrymen have been slow to recognize the benefits of chemical analyses for the reason that they had no one to interpret results and to use them to the best advantage. Today, however, they find that the installation of a chemical laboratory, or the employment of a commercial chemist, is one of their best investments. By the aid of the chemist and his analyses of raw materials the iron can be kept uniform in quality and mixtures can be made to meet any requirements. The chemist has not only proven a valuable addition to the operating department, but to the purchasing department as well.

In the foundry trade, as in all other lines of manufacture, supplies and raw materials are purchased on specifications, and when the material is received, it is analyzed to insure that the quality is up to the standard agreed upon by the seller. Competition between inferior and superior quality material is eliminated, and in this way proves a benefit to the seller who has material which will meet the specifications.

Foundrymen formerly bought their pig iron by brand and grade, but they have learned that as long as they can obtain iron containing the proper percentages of the elements to make their mixtures suitable for their work, the brand is not as important as heretofore. The same applies to coke.

The system of buying and selling material on chemical analyses is fair and profitable to both producer and consumer, providing the analyses reported on the material received is correct. Considerable time has been given to standardizing methods of making analyses and methods of taking samples, but practically no consideration has been given the preparation of samples for the chemist. The report of the chemist is of no value and is misleading, no matter how carefully the analysis has been made, if the sample is contaminated or in any way changed so that it does not represent the material on which he is reporting.

Sampling Coke.

Very few chemists appreciate the fact that coke is hard, particularly the 72-hour, bee-hive oven grade, and many seem to think it can be pulverized in almost any kind of a mortar, bucking board or grinding mill. The usual methods of pulverizing coke samples in a bell-shaped iron mortar, and on iron bucking boards, are wrong, as it is impossible to use either without cutting off fine particles of iron, which are not combustible and which will increase the percentage of ash in the samples. The percentage of ash is not only increased in the coke by the amount of iron weighed out in the sample for analysis, but the weight of the iron is increased by being converted to the oxide from burning off the carbon in the coke. Results on ash determinations have been increased as high as 10 per cent above the amount actually in the coke and have been the cause of very strong complaints and in many cases, rejection.

To ship material up to specification under such conditions, is impossible. The amount of iron from the mortar or pulverizing equipment contaminating the sample can very readily be seen by spreading the sample out on a paper and passing a magnet through it. Some chemists have claimed that the metallic iron taken out in this

manner was originally in the coal as pyrites and has been reduced in the coking process to a magnetic or metallic form. This theory can be easily proven right or wrong by taking six pieces of coke, breaking each piece in half making two samples of exactly the same material and pulverizing one in a large agate mortar and the other in an iron mortar or on a bucking board. If there is nothing magnetic in the agate mortar sample and there is in the other sample it does not take much reasoning to understand where the metallic iron comes from. Rubbing coke samples in a porcelain or wedgewood mortar to pulverize it, is even worse than in an iron mortar, for if anything cuts off the sides of the mortar, it cannot be detected.

Proper Method of Preparing Coke Samples.

The most satisfactory way of preparing coke samples is to pass the entire amount taken to represent a car or pile through a jaw crusher, breaking it down to ⅛ inch and under. It is then carefully mixed and quartered down to about 100 grams. A forged steel mortar, commonly used for pulverizing spiegeleisen, white iron, etc., is then used to break it down by hammering on the pestle until the entire amount passes through a 100-mesh sieve. Three or four grams at a time are put into the mortar and six to 12 blows given the pestle with a 4-pound hammer. The contents of the mortar are dumped into a 100-mesh sieve. What fails to go through is returned to the mortar with another portion from the sample and pounded again. This process is kept up, until the entire sample has been put through the 100-mesh sieve. It should then be thoroughly mixed before the chemist uses it. A piece of leather fitted tight around the pestle will prevent any loss from dust flying out, and prevent anything from falling into the mortar while pounding. Samples can be prepared as rapidly by this method as any other, and apparently is the only safe way.

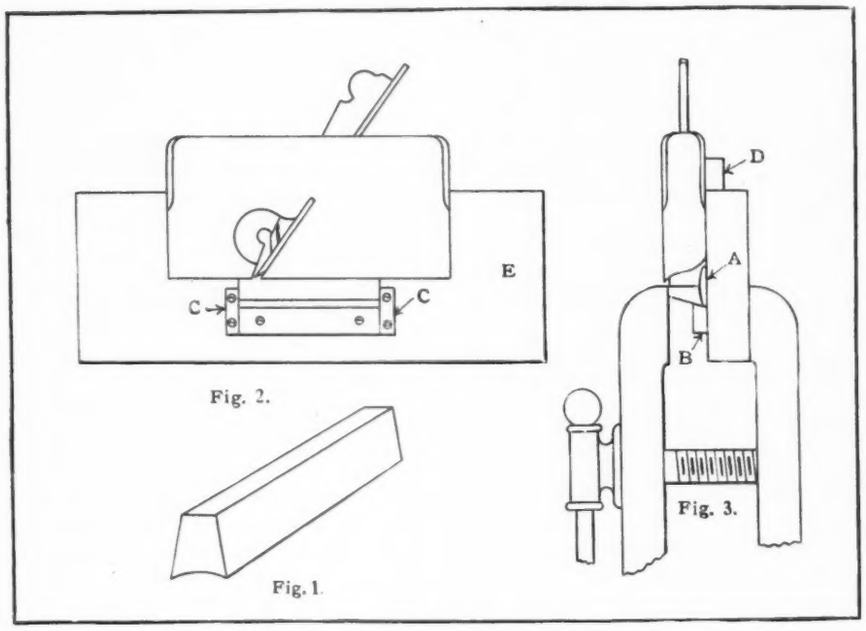
Variation in Analyses.

The difference in the analyses of coke prepared in various ways is shown by the following results:

	Per cent Ash.
Forged steel mortar	10.88
Porcelain mortar (not glazed)	13.67
Forged steel mortar	10.73
Iron mortar	12.80
Passing coke between two iron rolls, one roll revolving at twice the speed of the other	13.71
Forged steel mortar	10.88

A chemist recently reported on three cars of coke as follows: Ash, 15.50 per cent, 16.70 per cent and 19.90 per cent. His pulverized samples, which were received, contained a large amount of metallic iron. On investigation it was found that an iron mortar had been used. The same coke, sampled at the ovens and with the sample prepared in a forged steel mortar, showed only 11 per cent ash and contained no metallic iron.

The amount of coke rejected and the contracts cancelled through such errors in preparing samples is a matter of conjecture, but it is evident that if materials are to be bought and sold on chemical specifications the preparation of the sample must be done in such a manner that it will not become contaminated.



AN EASY METHOD OF MAKING TEETH FOR GEAR PATTERNS

Teeth for Gear Patterns

By Aug. Gertenback

AN EASY way to make the teeth for a gear pattern is to cut the stock, as shown in Fig. 1, the ends being trimmed to the proper length and the sides bevelled so as to leave no more stock than necessary, the curve being planed out on the bottom to fit the rim of the pattern. Next, a piece of lumber should be surfaced on one side and one edge, as at *E*, Fig. 2, and a block nailed on at *A*, Fig. 3, which is shaped the same as the rim of the pattern. A strip, *B*, is fastened below this, on which to rest the tooth, and pieces, *CC*, Fig 2, are attached in such a position that a line scribed along their top edges, on the end of the tooth, will be the center line of the finished tooth. Fasten the board, *E*, to one jaw of the bench vise, at such a height that the other jaw will hold the tooth in place while it is being planed.

A plane is adapted to the job by shaping the bottom and grinding the blade to conform to the shape of the tooth, after which the strip, *D*, Fig. 3, is fastened to the side of the plane to form a gage or stop. Holding the plane firmly against the side of the board, *E*, one side of the tooth is planed, and blocks and stops are arranged to plane off the other side to proper size and draft, as required. The center line is marked on the tooth while held in position, to facilitate the location of the teeth on the center line spaced off on the rim of the pattern. If carefully used, this rig will make all the teeth uniform, and will pay for itself in a short time.

Welding Cast Iron to Steel

Coat the steel with silicate of sodium, and before it is dry dust on dry, powdered ferro-manganese. The silicate will form a coat of glass over the clean surface of the steel, which is melted off by the molten iron. This keeps all air and moisture from the joint, and if no oxygen can reach the steel there can be no rust. If the surfaces are bright and the iron hot there will be an absolute union. One-inch steel bars, with the ends bedded in cast iron in this manner were tested, and broke off, but did not pull out.

THE BRASS FOUNDRY

Gating and Casting Large Bronze Rings

By C. Vickers

BRONZE rings or bushings, similar to those shown in Fig. 1, are familiar to most jobbing brass founders, who are frequently called upon to cast them. The usual practice is to make them one at a time, and gate from one or more points on the flange, the metal being thus dropped into the mold.

While this method gives good results with the smaller bushings, on larger castings, where several hundred pounds of metal must be poured into one mold, there is always danger of the metal cutting the sides and producing dirty

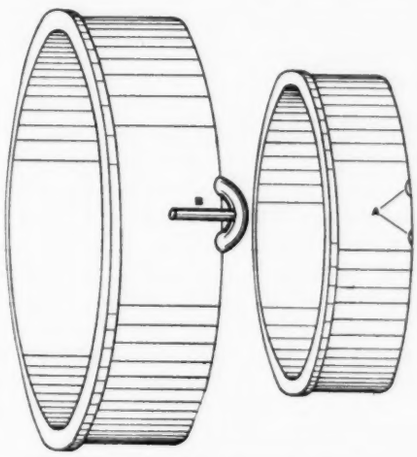


FIG. 1—PHOSPHOR BRONZE TURBINE RINGS

castings, when gated at the top. Therefore, it is always advisable to run them from the bottom, when they are generally gated in the manner shown at *A* and *B*, Fig. 1, *B* showing the gate attached, and *A* the scars after the gate was removed. This method of gating is not entirely satisfactory, as the metal impinges on the opposite wall of the mold, and although this point is usually protected by a core, which is rammed up with the mold, the continual impact of the metal is very liable to cut into the mold and wash away particles of sand.

Casting the Rings.

This was the method first tried in making the castings shown, and the results indicated there was room for improvement, as occasional losses occurred from dirty or misrun castings. It will be noted that the rings are cast inside of each other, and as it costs no more to ram two or three rings than one, it is a very economical arrangement and perfectly feasible with the gates shown. However, when the bushings were gated, as in Fig. 1, the inside ring had to be run from the outside one, because there was not space enough to put a runner down between the two and cast each separate, an arrangement anything but satisfactory. The method of gating, shown in Figs. 2 and 3, was, therefore, adopted and proved successful.

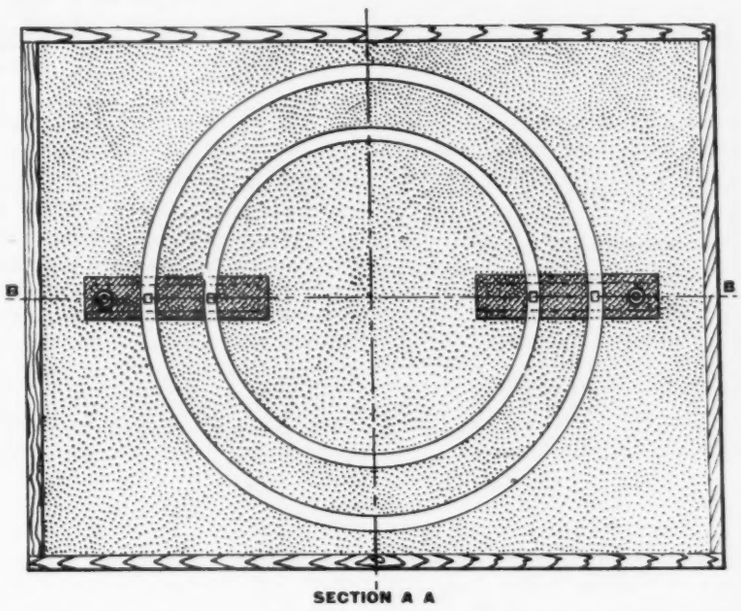


FIG. 2—PLAN VIEW OF MOLD FOR TURBINE RINGS, SHOWING METHOD OF GATING.

It will be noted that the gate was formed by a core and the metal entered the mold from the bottom, which reduced the cutting action on the sides to a minimum.

Gate Cores.

In the illustrations, the gate core is shown much larger in proportion to the mold than it really is, in order to make the description clearer. It will also be

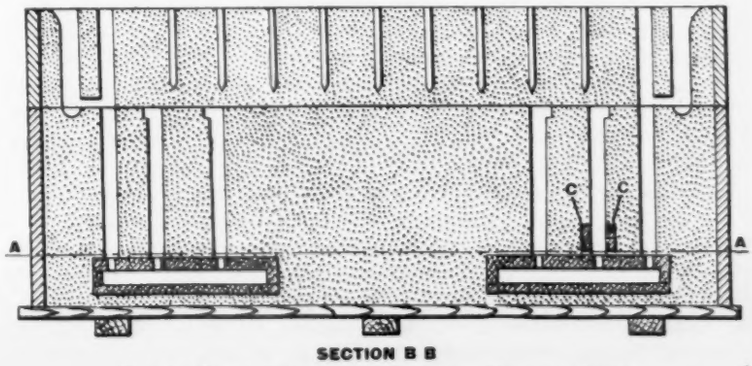


FIG. 3—CROSS-SECTION OF MOLD FOR TURBINE RINGS

noted that it is longer than necessary, as it extends considerably into the green sand center of the smaller ring. This is due to the fact that these inside rings are made in varying sizes, and as only one runner core box is used, it was made sufficiently long to reach the smallest ring molded. Fig. 4 shows the core in detail. It is made in two parts, one being shaped like a trough and the other a slab, and the latter is pasted onto the former, as shown in the sectional view. The trough part has two openings, a round one at *C* for the runner and a rectangular opening, which forms the gate for the largest ring, and which is always in the same position. The other gate opening, for the smaller rings, is cut through the core after its location has been determined, because, as the diameters of these rings vary, sometimes this opening may come at the end of the core and sometimes in the position shown in Figs. 2 and 3.

Making the Mold.

The gate cores are rammed up with the mold in the following manner: The patterns are placed flange down on the follow board and the cores are laid across the patterns with the gate, *D*, Fig. 4, in proper position on the larger ring. The position of the other gate opening for the smaller ring can then be located and the runner sticks can also be placed in position. The latter are pieces of broom handles, one end slightly tapered to fit into the hole, *C*, Fig. 4, and sufficiently long to reach from the gate core to the pattern board. The gate cores are then removed, the drag placed in position, and the ramming proceeded with until the patterns

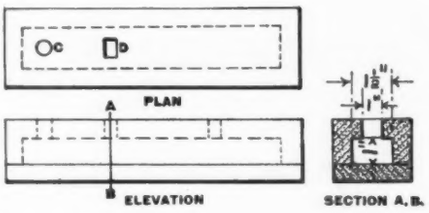


FIG. 4—DETAILS OF GATING CORE FOR TURBINE RINGS

are filled in to their upper edges, the gate sticks being also rammed up when the cores are tried on. The gate cores are then put in position and tucked solid, the drag rammed and rolled over, and the balance of the mold is finished. Although the metal rises into the mold very quietly and without impinging against the walls, it is always advisable to ram pieces of a slab core, as shown at *CC*, Fig. 3. This prevents scabbing or cutting at these points. While this is not as liable to occur as with the gate shown in Fig. 1, it is a contingency easily guarded against in this manner.

The castings shown were cut into rings, which were then slantingly slotted at close intervals, and metal vanes were calked into the slots, the mechanism being used in steam turbines. It will be understood, therefore, that the rings had to be perfectly clean and free from scabs, porosity and other blemishes. The castings were molded by hand, and one molder and a helper put up two molds each day, using 3,000 pounds of metal to pour off, as the large casting weighed between 800 and 900 pounds and the smaller over 500 pounds, which, with the two gates, required 1,500 pounds of bronze to pour each mold.

The metal was a phosphor bronze of the highest grade, the tensile strength of which varied from 38,000 to 42,000 pounds per square inch, with high elongation and elastic limit. With some shipments of copper, using all new metals, 42,000 pounds tensile strength was obtained, but usually 40,000 pounds was considered good, and when gates and scrap was used, the strength fell off considerably. The alloy used consisted of 90 per cent copper, 5 per cent phosphor tin and 5 per cent tin.

Light Weight Alloys for Aeroplanes

ONE of the most difficult and fascinating problems with which human ingenuity has ever grappled is that of aerial navigation, and the amazing success so recently achieved, is largely evolutionary, as it is in a great measure due to the present efficiency of the gasoline engine, for which the development of the automobile is directly responsible. It is recognized, however, that further improvement of air craft will be greatly facilitated by a decrease in the weight of the machinery, as economy in engine weight will increase the capacity to carry supplies, making a longer range of flight possible. With this end in view, a metal or alloy of low specific gravity is being eagerly sought to supplant the heavy metals now in use.

Unfortunately, the field of investigation is very narrow, being at present limited to the two metals, aluminum and magnesium, so that all the alloys so far developed have been constructed of varying proportions of these two elements, modified by small additions of the heavier metals. One of the latest discoveries in this line has received the name of *duralumin*, and is of German origin, as in fact are most of the light alloys. Extraordinary claims are made for this alloy and if only one-half of them are realized, this metal will rank as one of the greatest discoveries ever made in the alloying of metals. It is supposed to possess all the properties of steel and can be drawn, rolled, stamped and forged, either hot or cold. Its tensile strength reaches from 30,000 to 88,000 pounds per square inch, according to its degree of hardness, these qualities being found in an alloy containing from 90 to 95 per cent of aluminum.

Duralum.

Another metal of similar name, although older, is known as *duralum*, which contains copper and phosphorus in addition to magnesium. It has been made the subject of a patent by J. C. Mellen, of Bridgeport, Conn., the composition being given as follows: Aluminum, 79 per cent; magnesium, 11 per cent; phosphor-copper, 10 per cent. The percentage of phosphorus in the copper, however, is very low, being given as only 0.5 per cent. The actual composition of this alloy will no doubt differ very materially from what is herewith given, as 10 per cent of copper is exceedingly high, even in the absence of magnesium, and when the hardening effect of 11 per cent of this latter metal is taken into consideration, it is evident that the alloy would be too brittle to be of any practical value, as the presence of phosphorus will not modify the effects of such a high percentage of copper and confer ductility upon the alloy.

Magnalium.

Another alloy of magnesium and aluminum is *magnalium*. This metal, however, only contained small percentages of magnesium, the analysis showing from 1.58 to 1.60 per cent of this element, with small percentages of other metals, such as copper, nickel, tin and lead, the latter probably being an impurity. The specific gravity of this alloy varies from 2.5 to 2.57, according to the percentage of the heavy metals in the alloy, as several grades are manufactured of varying degrees of hardness and ductility. The addition of magnesium to alu-

minum hardens the latter metal. With 2 per cent magnesium, according to Prof. J. W. Richards, the tensile strength in sand castings was 17,900 pounds per square inch, with an elongation of 3 per cent, while with 10 per cent magnesium the tensile strength was increased to 21,400 pounds per square inch, with 2.40 per cent elongation. Chill castings, however, showed an interesting variation. With the alloy of 2 per cent magnesium, the tensile strength was increased to 28,600 pounds per square inch, and the elongation decreased to 2.00 per cent, while the 10 per cent alloy was increased both in strength and ductility, the figures being, 33,600 pounds tensile strength per square inch, and elongation, 3.40 per cent. The same peculiarity is seen in water-chilled castings, the 2 per cent alloy being increased in tensile strength to 40,000 pounds per square inch, and decreased in ductility to 1.00 per cent, while the 10 per cent is increased to 61,100 pounds tensile strength with 4.20 per cent elongation.

Magnesium Alloys.

Another series of light alloys substitute magnesium for the basic metal in place of aluminum. This produces a lighter metal, as the elements of high specific gravity with which the magnesium is alloyed, exist only in small proportions. One of the latest patents in this direction contains from 80 to 95.5 per cent of magnesium and from 0.5 to 20 per cent of other metals, principally aluminum, and it is claimed they can be readily machined, soldered, welded, forged and cast. An alloy of 92 per cent magnesium and 8 per cent aluminum, it is stated, has a specific gravity of only 1.75 per cent and is equal in strength to the best gun metal, etc. This is a very broad claim, and one that the experienced metallurgist will be likely to doubt. Gun metal, or bronze, can be made to combine both high tensile strength with high elongation, or ductility, which will be retained indefinitely and can be depended upon, while the white metals of low specific gravity lean more to the nature of cast iron when alloyed, and high tensile strength is only attained at the expense of ductility. This is especially true of the bluish white metals, zinc and aluminum, and although magnesium is not tinted blue and inclines more to silver, it possesses many of the characteristics of zinc. Various serviceable magnesium alloys, however, have been produced and patented and given attractive names, such as *electron*, *ruebel bronze*, etc., and will no doubt be found of great value in aerial work, provided they are not discredited by extravagant claims, which may cause them to be used for purposes to which they are unsuited and where failure may occur and bring disaster.

Magnesium.

The specific gravity of magnesium is 1.75, a cubic foot weighing 108.62 pounds. It is, therefore, considerably lighter than aluminum and in some ways resembles zinc, as it is crystalline when cast, and tough and ductile when rolled. It is produced in the form of square sticks, which were formerly sawed out of cast slabs, but at present are rolled. It cannot be used to alloy with copper in quantity like zinc, as even such a small amount as one-half of 1 per cent will destroy the casting qualities and ductility of ordinary yellow brass, while 3 per cent makes copper brittle. Magnesium would be one of the most valuable of metals to the brass founder if its general resemblance to zinc extended to its casting qualities, so that it could be used in alloy with copper in the same proportions as spelter. Such alloys would come intermediate in specific gravity between aluminum and copper, and would form a kind of missing link among alloys, combining low specific gravity with the strength of manganese bronze. This, however, is not possible with magnesium, and it must either be employed as a base with small percentages of other metals, in the same general way that zinc is modified, thus producing an alloy of low specific gravity, high tensile strength, great hardness and with practically no elongation, or it must be employed in small proportion to improve the properties of some other metal.

Lithium.

Aluminum and magnesium, however, are not the lightest metals known to the chemist, as there are several which possess a much lower specific gravity, but there is very little possibility that any of them will prove of value in the construction of engineering alloys. The lightest metal known is *lithium*, with a specific gravity of 0.57 and weighs 36.83 pounds per cubic foot, while gun metal, according to Haswell, containing copper, 90 per cent, and tin, 10 per cent, has a specific gravity of 8.832 and weighs 541.17 pounds per cubic foot, the difference between the weight of a cubic foot of these metals is, therefore, 504.34 pounds. Therefore, if it were possible to build engines of lithium, or an alloy equally as light, an enormous saving in weight could be effected, permitting a considerable decrease in the size of the sustaining planes, resulting in a smaller, speedier and more compact machine, which would even float on water. Lithium, however, possesses fatal defects for such use, as it belongs to the alkali metals, a group which contains sodium, potassium, and calcium. Most of these metals are so soft that they can be easily cut with a knife and possess such a powerful affinity for oxygen that they are able to decompose water. They are all lighter in weight than magnesium, the specific gravity of potassium being 0.87, and sodium, 0.97. Calcium is considerably heavier and comes next to magnesium, with a specific gravity of 1.57. Lithium melts at 180 degrees Fahr. and burns in the air with a bright carmine red flame, at 200 degrees Fahr. It may be welded by pressure at ordinary temperatures, and is, therefore, too soft for mechanical purposes, even if it possessed stability. These metals, therefore, cannot be used alone for any mechanical purpose, as they possess few of the characteristics usually associated with metals, and there is very little possibility that their alloys will be of any value, as they could not be used in sufficient quantity with other metals to appreciably lower their specific gravity and produce a serviceable alloy. Although sodium is soft, its effect on other metals is to harden them, and a soft, ductile metal like tin is made so brittle that it can be quite easily broken by the addition of 3 per cent of sodium.

Rubidium.

Another metal of the alkaline group, which may be given passing notice, is *rubidium*. This metal has a specific gravity of 1.52 and comes between calcium and sodium. At present, it is not a commercial possibility as a means of making alloys.

Beryllium.

The same also applies to *beryllium*, which, according to Nilson and Petterson, has a specific gravity of 1.64, making it lighter than magnesium. Other authorities, however, place its specific gravity at 2.01 and 2.07, which makes it heavier than magnesium and lighter than aluminum. At present, this is a rare metal and is found in the emerald and beryl, from which it derives its name. It is also known as glucinum. Its qualifications for aerial engineering are theoretically excellent, as according to Menedeleef, it melts at nearly the same temperature as silver, which it resembles in its white color and luster. Beryllium is oxidized with difficulty, in fact it seems especially able to resist oxidizing agents. It also resists nitric acid, both pure and dilute, and will not burn in oxygen, nor decompose it at ordinary temperatures, or even at a red heat. These qualities, coupled with a very low specific gravity, make this metal a very desirable one

for all aerial work, but at present it seems a very remote possibility, and it is doubtful if its ores occur in sufficient quantity to justify the prophecy that it will ever be used as extensively as aluminum, which, only a comparatively few years ago, cost $100 per pound. If a better acquaintance should confirm past investigations that this metal combines the specific gravity of aluminum with the infusibility of silver and the acid-resisting properties of gold, it would be an exceedingly valuable metal, both alone and in alloy with other elements, as experience has shown that all metals, which combine great tensile strength with high elongation, melt at high temperatures, like steel, copper or silver.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Copper Castings

Can you inform us whether it is possible to make solid copper castings by the use of chemicals or flux, and without the addition of silicon, copper, zinc, phosphor-tin, etc., commonly used for such purposes? Some time ago we were called upon by parties who claimed to be able to do this, also to temper copper, but when given a chance to prove the truth of their statements we found they used tin up to 5 per cent in their tempering, and could not make castings solid without it.

Various fluxes can be used to make copper castings solid, without the addition of any of the elements mentioned. Yellow prussiate of potash is one of the best-known of these fluxes, and from 1½ to 2 per cent will be found necessary to insure entire freedom from holes. This chemical adds iron to the copper and it is due to the deoxidizing effect of this metal that the copper can be cast solid by this method. The following flux will also give solid copper castings: To 1 pound of phosphate of lime add 1 pound of ground charcoal and wet with 1 part sulphuric acid to 2 parts of water. Allow this to stand over night, then to 15 pounds of molten copper add 1 pound of flux wrapped in paper. Allow it to remain on the surface of the metal until dry, then stir well. The copper should remain in the furnace 15 minutes after the addition of the flux. The resulting castings will be solid, very tough, and the presence of phosphorus cannot be detected by the appearance of the molten metal. Copper can be tempered, so as to ring when struck, by the addition of the following flux to 30 pounds of copper: Calcium phosphate, and yellow prussiate potash, 8 ounces each; sulphur, 4 ounces; bichromate of potash, 4 ounces; soda ash, 4 ounces; salt, 2 ounces; add an equal bulk of coke dust and wet with water. This will temper quite hard and the flux must be added, one-half when the copper is red hot and the balance when molten. Solid copper castings can also be made by adding to every 10 pounds the following flux: Calcium phosphate, 2 ounces, mix with water to a thick batter, add ½ ounce sulphuric acid, let stand 1 hour, then add 1 ounce of bichromate potash, 6 ounces of chalk and 2 ounces of charcoal. Wrap in paper and drop on the surface of the metal and when dry stir in. All these formulas have actually been used, and copper castings made in sand from them in usual foundry practice. Experiments with the latter flux showed the minimum quantity that could be used was 10 ounces of flux to 40 pounds of copper, the addition of tin being entirely unnecessary.

Bearing Metal

We have experienced trouble in producing bronze bearings free from what appear to be shrink holes containing small beads of lead. We understand that the trouble comes from pouring the metal too hot, or from not stirring it enough in the crucible to insure uniformity. The alloy is a phosphor bronze containing 85 per cent copper, 6 per cent tin and 9 per cent lead. Can you inform us what is the cause of our trouble?

The lead is not responsible for the shrink holes, which in all probability are caused by insufficient head on the molds and the first thing to do is to prevent the shrinking by raising the heads or using heavier sprues or feeders. After you have the castings free from shrink holes, if the lead still sweats, regulate the amount of phosphorus so that it will be equal to what would be added by 2 pounds of 15 per cent phosphor-copper, and add to this 1 per cent of 30 per cent manganese-copper. This will cure your trouble, which does not arise from pouring too hot or insufficient stirring. The alloy you give is not one to be recommended as it seems especially liable to cause trouble and the following alloy is much better for bearings: Copper, 80 per cent; tin, 10 per cent; lead, 10 per cent; no phosphorus. If this is too expensive, however, try the following: Copper, 77 per cent; tin, 8 per cent; lead, 15 per cent; no phosphorus. This alloy is a little cheaper and a much better bearing metal than the one you are making.

Base for Crucibles

We use the regulation coke furnaces in melting brass, and would like to have your advice as to the use of a brick base under the crucibles. We have tried one several times and it seemed that the heats came out quicker, but the question is whether it affects the life of the crucible.

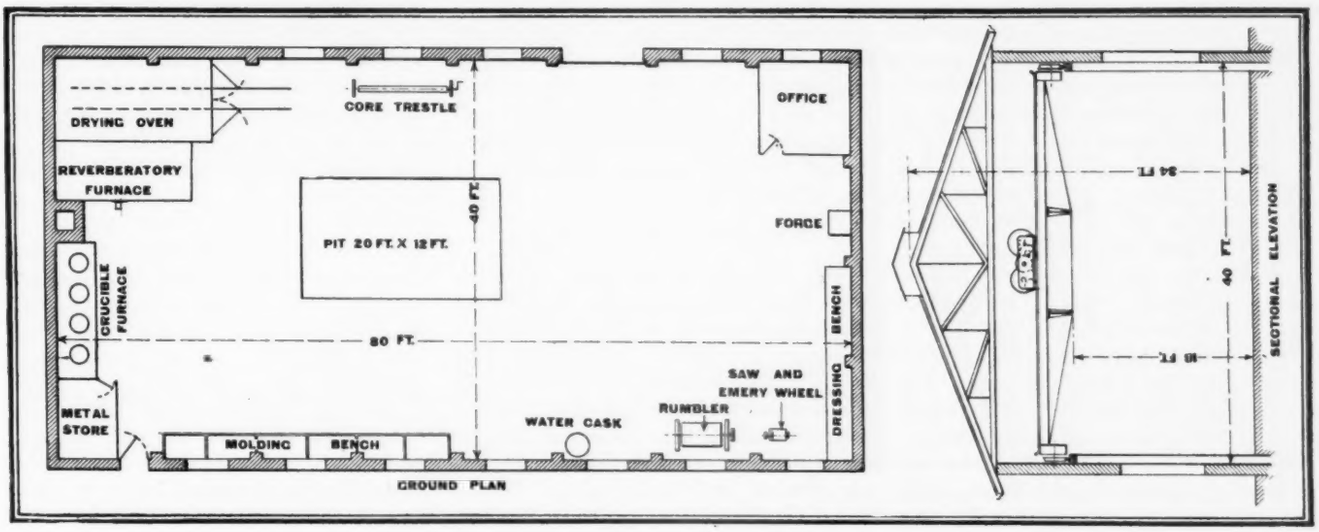
A crucible base, improperly used, will generally shorten the life of the crucible. With proper care, however, it is an advantage with certain kinds of fuel, as by its use the necessity of raising the crucible is avoided. Some grades of coke burn to a dry ash and form few clinkers, the grate bars therefore, remain comparatively clear, and the dust-like ash sifts through into the ash pit. This is notably the case with 72-hour coke when burned in straight shaft furnaces. With such coke therefore, it is better to use a base under the crucible, because otherwise, as the coke burns and disappears as ash, the crucible settles in the furnace, and on reaching the grate bars there is no live fuel beneath it, and the bottom is chilled. The pot then has to be raised and a new bed put under as well as around the sides, which considerably cools the metal, thus losing time in melting. This is a somewhat extreme case, which in

practice is avoided by careful attention to the fires, but it will happen to some extent, and illustrates the value of a base to maintain the pot at a proper height from the grate bars. Such a base is a necessity in melting refractory metals such as ferro-manganese, nickel or steel in coke furnaces, as it will be found advisable and it might be said expedient, to use 72-hour coke for such purposes. Soft grades of coke produce a sticky fire which clinker more. These clinkers melt down to the grate bars to which they attach themselves and their soft upper surface forms a bed for white hot coke. When the crucible, in its descent, reaches this bed, the bottom is kept hot, and provided the metal is melted, it is seldom necessary to raise the pot when recoking for the superheat, therefore, such fuel gives excellent results for brass, without a base under the crucible when properly managed. The base should either consist of a brick or of crucible material, preferably the latter, and should be of the same or a little larger diameter than the bottom of the crucible so that the walls of the latter are supported by the base, as well as the bottom. When a brick is used for a base, it is generally broken in two, and one half placed on top of the other. This base is even too small for a No. 35 crucible, and when used under a No. 50 pot, as often happens, the crucible gradually upsets, that is, the unsupported walls sink and the bottom is pushed up, producing an enlargement just under the bilge. This enlargement continues to grow in successive heats, until it produces a rupture, and the pot will be found to have lost about 50 per cent of its normal life.

Brass Foundry Layout

At present we are making brass castings at one end of our gray iron foundry. We find that our trade in the brass business is increasing so rapidly that it will be necessary for us to open a separate shop to handle it. Can you advise us about the general layout of a brass foundry, suitable for heavy jobbing work for ships, sugar mills and mines? We want to equip for making castings up to three tons in weight and the space available is 40 x 80 feet; core benches and flask storage are not required.

For heavy work of this class the main features of the layout will be the position of the furnaces and the casting pit. The accompanying illustration shows a convenient arrangement of the plant ready. The metal store has an important place in the brass foundry. It should be provided with a weighing machine and the floor should consist of boiler plates. Old plates will do, providing they are flat and without holes. The space inside is partitioned off into as many divisions as there are kinds of metal to be stocked.



GROUND PLAN AND SECTIONAL ELEVATION OF BRASS FOUNDRY

required. Heavy work calls for more floor space per molder than light work, hence we have made a generous allowance for this feature. One or two wall cranes could be introduced to relieve the traveler and additional equipment, such as a sand mixer, grinding mill, pneumatic chippers, etc., could be placed where required, with advantage. Municipal electricity being available, we would advise you to use it for the rumbler, emery wheels, etc. To use the reverberatory furnace for a heat of less than a ton would be unprofitable, so it might be advisable to put in one of the tilting oil or gas melting furnaces to supplement the crucible furnace, in fact, the latter could be cut out and a battery of the former substituted. This would have the effect of doubling the melting capacity for the general floor and bench work and the reverberatory furnace would only be brought into use when sufficient heavy work for a heat was

Phosphor Bronze Castings

We have an order for a quantity of phosphor bronze castings, the tensile strength of which must be as high as is possible, and which will not be accepted if below 39,000 pounds per square inch. Can you give us a formula that will meet these requirements? What is the best method of adding the phosphorus, by the use of phosphor-tin or phosphor-copper?

The following formula can be recommended: Copper, 90 per cent; tin, 4 per cent; phosphor-tin (5 per cent) 6 per cent. Use a brand of lake copper containing a small percentage of arsenic, and when charging the ingots do not allow the ends to project above the pot, so that the furnace gases can strike them. The balance of the copper charge should be placed where the ingots will become warm, but it is not advisable to put them on the side of the pot, because they will absorb sulphur from the fuel, and be injured thereby. They are added to the melting metal when it begins to sink down, and before it is entirely liquefied. They are then kept from immersion in the already molten metal by the red hot ends of the ingots first charged, and by the time these sink

down, the newly added metal is red hot and in a position to follow without danger of chilling the molten mass. When all the copper is melted, add 1 pound of phosphor-tin, and stir well. Close the furnace and allow the alloy to become sufficiently heated to pour, then add the balance of the mixture. It is of course necessary to use charcoal all through the progress of the melt. Another alloy that can be recommended, if for any reason the mixture already given does not come up to requirements, follows. Copper, 89 per cent; 15 per cent phosphor-copper, 6 per cent; tin, 5 per cent. Melt in the manner outlined for the other alloy but add the phosphor-copper before the tin. The same results are obtained whether the phosphorus is added in the form of phosphor-tin or phosphor-copper. Sometimes, however, the latter is more convenient, as any amount of phosphorus can be introduced that is thought desirable. The last formula, for instance, carries more phosphorus than could be added by means of phosphor-tin, consequently phosphor-copper is the only alloy which can be added, unless yellow phosphorus is used. This mixture will be found very fluid and searching, and unless the proper casting temperature of high phosphorus bronze is understood, it is advisable to black the molds with plumbago and bake or skin dry deeply.

Making Patterns for Brass Valves

By Frank B. Lucas

THE method of making valve patterns, herewith described, is not intended for a cheap or one casting job, as it would not pay, but it will be found very practical and inexpensive when such castings are made in quantities. The first thing to consider is the layout. This should be made on a well battened piece of pine and given a coat of thin shellac. Pine is preferred to mahogany for the reason that the lines will show much plainer, and when shellaced, will be as plain as any drawing or blue print, provided they are penciled in after the valve has been laid out.

Fig. 1 is a plan view of a 3-inch wedge gate, non-rising stem valve, with a screwed or flanged end. This means a valve having a wedge gate, generally tapering 1 inch to the foot, and a corresponding tapered disc that screws upon the stem when the valve is opened. The stem is held in the neck of the valve by a collar, and screws into the disc and lifts it when the valve is open. This style insures a tight valve seat and the packing around the stem is always secure. There is, furthermore, no danger of bending the stem when the valve is opened, as in the case of a rising stem valve. The tapered seat for the disc, in the valve body, is finished off by bolting the casting onto a beveled face plate, which has the same taper as is required on the valve seat, and is turned off in a vertical boring mill or on a lathe.

Valve with Flanged Ends.

The valve shown in Fig. 1 is made with flanged ends and the double lines show where finish is allowed, and in this case amounts to 1/16 inch. The valve is also made with hexagon ends for screwed pipes or fittings, in which case it assumes the shape outlined by the dotted lines. These hexagon flanges are joined to the body by ribs, *AA*, Fig. 1. This strengthens the flange at this point and the sand is less liable to be washed away when the iron is poured into the mold. These ribs are made fast to the hexagon and no mark is left on the pattern body when the flanges are interchanged, the rib being omitted on the flanged end style shown. Another reason for this is that the pieces are less liable to be lost than if they were loose on both pattern and flange.

Fig. 2 is the end view of the valve, showing the section through the neck at *XY*, Fig. 1, also the ribs, *RR*, Fig. 2, that guide the disc when it is moved up or down in the valve. One side is purposely made thicker than the other, thus making it impossible to place the disc in the valve backwards and making a leaky joint. The location of the ribs, *AA*, Fig. 1, is shown by the dotted line, *B*, Fig. 2.

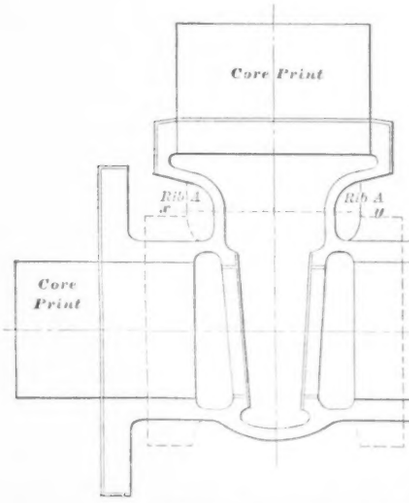


FIG. 1—PLAN VIEW OF STEM VALVE

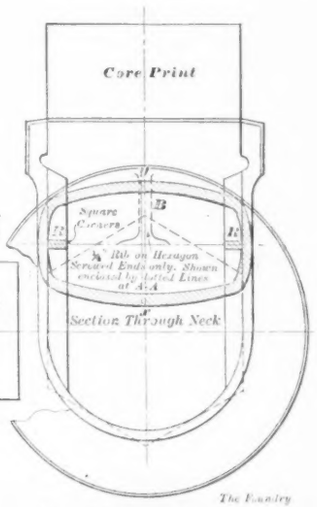

Core Print
Square Corners
Rib on Hexagon Screwed Ends only. Shown enclosed by dotted Lines at A-A
Section Through Neck
The Foundry

FIG. 2—END VIEW OF THE VALVE

Turning the Pattern.

Any small pattern that will warrant the making of metal core boxes should be made either of metal, or as in this case, of mahogany. Select good, clear-grained stock for the pattern and after joining it up in two halves, bore holes and screw brass dowel pins into the center of each core print. The best way to lay out where these points will come is to drive a brad in about one-half way its length and cut off the head, leaving about 1/16 inch above the surface for a marker. Then by placing the other half on top, keeping the sides and ends even, and hammering it lightly, the exact point is transferred on both sides of the pattern. Put in the pins and screw and dog the two halves together. Turn the stock off to the shape shown in Fig. 3, setting the hexagon flanges to be recessed into the main part ⅛ inch or so, the width being from the face to one-half of the fillet. Two screws hold each flange in place; a center line, made while the piece is in the lathe, is also necessary to the attainment of a perfect casting. Space off the prints at each end with the dividers and turn in ½ inch, leaving the surplus stock on until the pattern is nearly finished. Clamps can then be

put on these ends when glueing the branch on with no fear of marring the pattern.

The branch is jointed up in halves in the manner described and turned up to the required size, as in Fig. 4. Only one dowel in the center of the print is needed here and the straight part is carried to the middle of the valve and a center line turned on in the lathe as was done on the body.

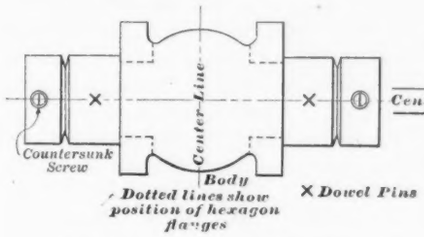


FIG. 3—THE VALVE PATTERN

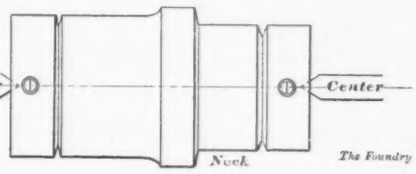


FIG. 4—THE BRANCH PATTERN

Joining the Pattern.

When the two parts have been turned exactly on the center, the two drag halves can be easily joined together, "stepping" them, as it is termed. The flanges are marked and removed from the pattern, the steps are then laid out, and cut on the saw, as at *A* and *B*, Fig. 5, tacking a strip along one side as a guide. These two pieces can then be glued and screwed together and clamped to a surface plate until dry. The cope half is fitted in the same manner and these two jointed halves clamped together with tissue paper between, until dry.

Laying Out the Neck.

The best way is to lay out the neck on the drag half of the pattern, and from the layout obtain the distance from the center to the point of intersection of the two radii, shown in detail at *X*, on *D*, Fig. 5. By scribing a line through this point, on each side of the center line, two definite lines are ascertained, with which to work off both side sweeps of the neck to a thin wood template. These two lines are by the eye, the shape being the main feature and test of this part.

The large round flanges are made up of segments, glued and turned up separately in halves to fit the recess used for the hexagon flanges. These can be run through the circular saw for cutting the two sides that are parallel to the joints, the other sides being cut on the band saw and finished on a sharp trimmer, setting the angle at 60 degrees. Next, cut off the stock at the ends of the prints and round over the ends; then shellac and the pattern is completed.

The core boxes for this valve are to be made of iron, and the master patterns for these iron boxes are made of plaster. Only one shrinkage is allowed, because the boxes are file finished and the first step is the making of the core sticks.

Core Sticks.

The main core is the one for the disc recess, and half of the box for the same is shown in Fig. 6, which gives plan, sectional and end views of the completed iron box, with dowel pins omitted. To get this shape in plaster, a core stick is made, to conform to the outline, as shown in the longitudinal section, Fig. 6. As one core stick makes both halves of the box it is turned up in halves, but not exactly, as is the case of the pattern, the stick being turned 1/16 inch off center so that one-half is just that much more than

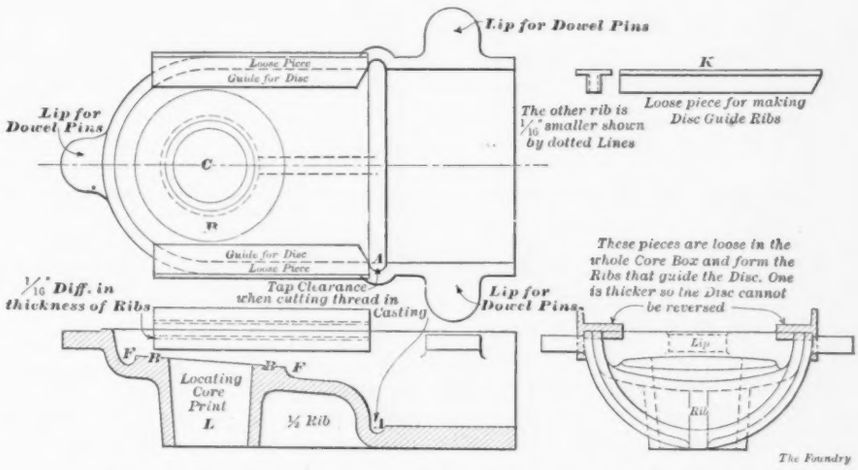


FIG. 6—PLAN, SECTIONAL AND END VIEWS OF THE CORE BOX

a half circle. This allows 1/16 inch finish on the face of the iron casting. At first turn up the stick to the size of the core print and the tap clearance, *AA*, Fig. 6. The large half is then screwed to a face plate, centering it on the plate with the center, *C*, and a ¾-inch hole is bored at this point to locate the core print, *L*, Fig. 6, when it is turned up and beveled off. The stick is then centered on a beveled face plate, which has the same taper as the disc, and the fillet, *F*, and the surface, *B*, are turned to the required dimensions; then the locating core print, *L*, is turned up with a ¾-inch spindle, and this is beveled off until it fits snugly against the beveled surface, *B*.

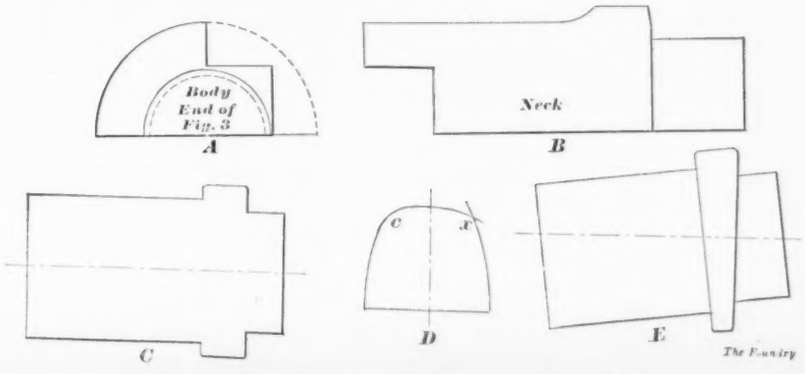


FIG. 5—PARTS OF THE PATTERN AND CORE BOX

Making the Plaster Box.

The core stick should be finished smooth and given two or three coats of

shellac varnish. When perfectly dry, it should be screwed to a level, shellaced board. A frame is then made as high as the core stick, plus the metal thickness, in this case from the joint of the box to the top of the locating core print. This frame is held together with screws in each corner, the whole frame being attached to the bottom board. The width and length of the frame is governed by the lips for the dowel pins. One side of the frame is placed against the end of the large print; this forms the only opening through which the core is rammed. The pattern frame and bottom board are then well oiled, using half oil and half grease, applied with a camel's hair brush or soft rag. The box is then ready for the plaster.

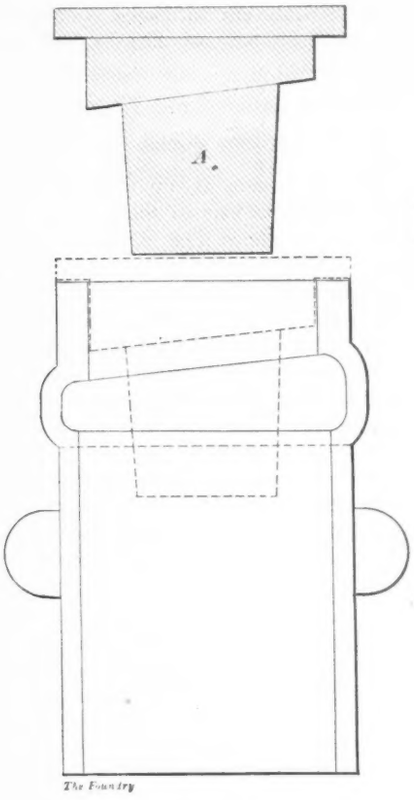


FIG. 7—LEFT HALF OF CORE BOX FOR SIDE CORE WITH THE METAL CORE PLUG *A*

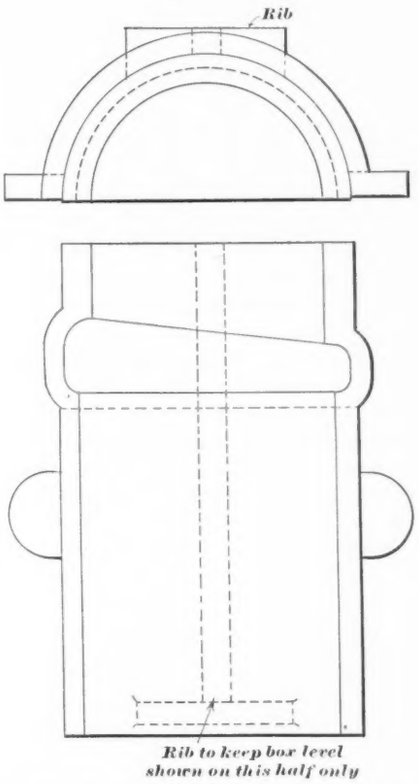


FIG. 8—RIGHT HALF OF CORE BOX FOR SIDE CORE

Pouring the Plaster.

The proper way to mix and pour the plaster is as follows: Into a large pail pour enough cold water to cover the core stick in the frame. Then sift in dental plaster up to 1 inch, or 1½ inches, of the top of the water in the pail. Then stir it, adding as much more plaster as may be needed to bring it to the consistency of thick cream. The reason for not stirring in the plaster at the start is that clear water absorbs the plaster more readily than when it is mixed with the water, which is the case when stirred while adding the plaster.

Pour the mixed plaster over the core stick, tapping the frame to jar bubbles and impurities to the top. When partly set, strike-off the surplus with a straight edge and let it set until it begins to feel warm. Then unscrew the core stick and frame from the bottom board and turn over the frame and plaster. Next carefully remove the frame from the plaster cast. The core stick is easily withdrawn at this stage, as the heated plaster melts the grease, which forms an efficient parting, although if the shellac was not given time to get hard on the core stick, the heat of the plaster will soften it and make it stick. If any pieces of plaster chip off, they can be attached with thick shellac, after which the entire inside is shellaced. The outside of the box is then trimmed off and shaped as desired, the two loose guides for the disc, *K*, Fig. 8, and the finishing up of the metal box are generally left for the metal patternmaker.

The Side Core.

Both side cores being alike, one box does for both. The stick is turned up in halves, as outlined at *C*, Fig. 5, and as both halves are to be used for each half of the box, left and right, is should not be turned up 1/16 out of center, as in the other case, but a piece of cardboard, 1/16 inch in thickness, is shellaced on the joint instead. It is next turned to the shape shown at *E*, Fig. 5, by laying out a center line on the joint, at right angles to the bevel on which it is to be turned, and re-centering the piece on these new centers. Fig. 7 shows the left half of the box with the metal core plug, *A*, that forms the recess for the locating core print, *L*, Fig. 6. Its position in the box is shown by the dotted line. This is doweled to one half of the core box only, and is usually turned from a piece of machine steel and the tapered collar soldered or riveted on afterwards (although on large work this is a separate pattern). This plug is not in halves, but turned up solid, as shown. Fig. 8 is the right half of the same box, showing the ribs on the bottom, to keep the box from rolling when the cores are being made.

Casting Brass on Iron

By Louis Luhrson

REFERRING to an article recently published in THE FOUNDRY, entitled, "Casting Brass on Iron," a method which we have developed in our shops, might prove of interest to those seeking this information. To cast the brass on a cast iron wedge or shoe, the casting is planed and two dovetail grooves are cut diagonally across the plate, as shown in Fig. 1, and to hold the brass at *A* and *B*, two 5/8-inch holes are bored at these places, countersunk on the reverse side of the plate. To

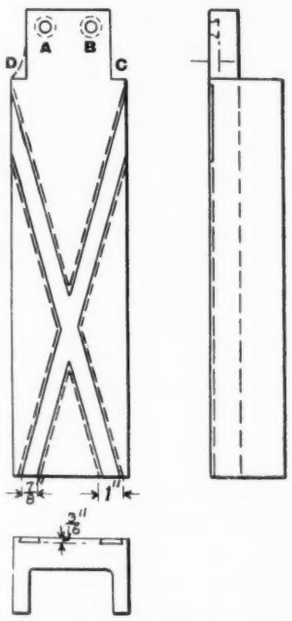


FIG. 1—PLAN AND SIDE ELEVATION OF GROOVED CAST IRON WEDGE FOR SEATING THE BRASS PLATE

avoid the sharp corner at *C*, this has been rounded, as shown at *D*, to permit the metal to flow freely to the bottom of the plate. A pattern should be made, the thickness of the brass plate desired and having the shape of a cast iron wedge or shoe. As emphasized by other writers, who have discussed this subject heretofore, cleanliness is essential to insure a good job. The pattern is then placed on a follow-board and on top of this the cast iron wedge is set in position, having previously been warmed, but not heated sufficient to cause sweating. The drag is then rammed, the mold is rolled over and the pouring gate is cut at the widest end of the mold and the riser is taken off at the other end. The gate should be cut large and the full width of the pattern. As shown in Fig. 2, the pouring gate should conform to the lip of the crucible so that no time will be lost in getting the metal into the mold, as it chills very rapidly running over the face of the cast iron wedge. After lifting off the cope, the pattern is sponged very lightly and is lifted away from the iron wedge. The mold, Fig. 2, is then ready for the metal.

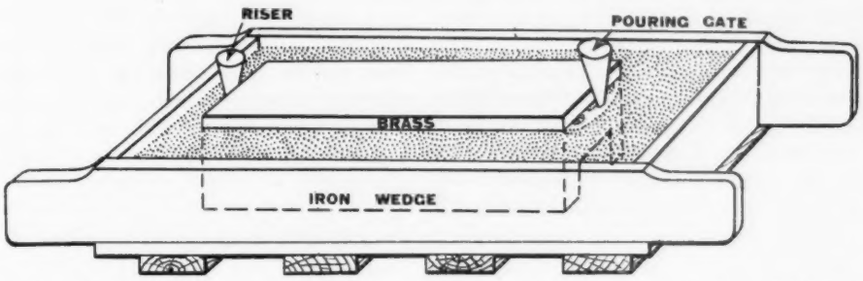


FIG. 2—ARRANGEMENT OF THE MOLD FOR CASTING BRASS ON A CAST IRON WEDGE

Care should be exercised to have the face of the wedge absolutely clean, as anything on the surface, such as water or grease, will create steam or gas during the process of pouring and a kick will result which, while not always spoiling the job, will leave an ugly lump on the casting, involving an extra machining expense. The following mixture has given satisfaction on this work: Copper, 30 pounds; tin, 2½ pounds; lead, 2½ pounds; car brass scrap, 65 pounds.

The Brass Scrap Pile---III

By C. Vickers

SCRAP white metals may be taken to include all metals and alloys that contain lead, tin or zinc as a base, and comprise scrap lead, zinc, pewter, tin foil, tea lead, type metals and their drosses, as well as the numerous assortment of babbitt metals which are generally in the form of drosses when they reach the scrap stage.

Babbitt Dross.

Babbitt dross will be considered first, and it may be stated that it is not usually looked upon by the brass founder in the light of a good investment, in fact in the disposal of babbitt drosses the founder is usually the seller and the scrap man the buyer, though often a somewhat coy and cautious one. Every scrap metal dealer who occasionally handles such material knows that babbitt skimmings are always taken from the tin babbitt kettles, and if there are any leaded mixtures, their drosses are always kept separate and the zinced skimmings apart from these. As it is difficult to tell just what mistakes "the boy" may have made, and how he may have got things mixed, the purchaser being a wise and prudent man, always insists on samples being submitted and then occasionally gets the worst of the deal from his failure to have them analyzed.

Buying Scrap.

There is little danger in purchasing such material upon analysis, the bids being based upon the value of the metals shown by the sample, and another analysis is taken when the material is received. In this way the buyer has a good idea of what he is doing and is not working in the dark. But, the scrap dealer who acts in the capacity of a middleman does not always feel like going to the expense of an analysis and, therefore, occasionally gets into trouble. An illustration of this occurred recently in the case of a dealer who purchased a considerable quantity of babbitt skimmings from the shops of a western railroad, and previous experience having assured him that the material was higher in tin than was figured. He purchased it without analysis and later found, to his sorrow, that some genius had changed the formula and "improved" the babbitt with the addition of several per cent of aluminum. Thereafter he refused to purchase babbitt drosses. He was, however, always ready to buy old boilers, because he obtained an ancient one once for a song, on condition that he remove it in an extremely limited time and on a Sunday. In doing so he broke all records, and accomplished the job with such celerity, that competitive bidders were filled with wonder and admiration until they later learned that the rusty looking old relic, underneath its coat of bricks and tar, was made of heavy rolled copper.

Determination of Aluminum in Babbitt.

It is very easy, however, to determine whether a babbitt contains aluminum or not, even if it is not convenient to have an analysis made. All that is necessary is a furnace in which small amounts of copper, or brass, can be melted and it is very easy to install one in some corner of the shop. There is generally some employe who can mold or look after the furnace, who can be easily broken in to make the tests necessary to get a very good idea of the contents of suspicious metals or drosses. In addition to the furnace, there will be required a small crucible or two and tongs to fit, also a few small ingot molds.

Judging the Content of Scrap Metals.

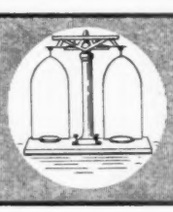
One of the safest methods of discovering if a metal contains anything objectionable, is to melt it. Suppose there is some red metal and it is suspected of being phosphor bronze. Melt down some of the material and pour an ingot. When melted, it is easy to see the phosphorus. If in the case of babbitt suspected of containing aluminum, melt down 10 pounds of copper and add 1 pound of the babbitt. If it contains either aluminum or silicon it will become visible, as the surface of the metal will look like a red hot mirror, and when run into ingots the upper surface will be quite smooth, with a deep depression down the center. It is rather difficult for any but an expert to detect the presence of aluminum from silicon while the metal is in a molten condition, as there are certain little color changes which flash across the surface when it is disturbed, which reveal the presence of these metals to an experienced eye and enable the one to be distinguished from the other. But in the case of an alloy in which babbitt drosses are used as

the mixture, it is always safe to assume that the disturbing element is aluminum, because silicon cannot be used in babbits, as it causes such enormous loses through drossing, that once used, it is never used again. If, however, the trial heat of 10 pounds of copper to one of babbitt shows none of the characteristics mentioned, and the surface of the skimmed metal presents a dull appearance and as it cools contracts into little wrinkles, the alloy contains no aluminum.

Judging Babbitt Metal.

While the metal is melted, it is easy to determine if the babbitt contains zinc, because if it does, the metal will smoke and a gyrating blue flame will appear on the surface when heated more than usual. The volume of smoke will give some idea of the amount of zinc contained, as a large amount of smoke will indicate that a large amount of zinc is present, and vice versa, but the quantity cannot be determined with accuracy in this manner. If the metal does not smoke the babbitt consists of some alloy of tin, copper and antimony, or tin, copper, lead and antimony. If the former, the babbitt will be of high grade, because it is rare to find more than 10 per cent of copper and 10 per cent antimony in such alloys and generally less, consequently such babbitt will contain from 80 per cent upwards of tin.

If lead is also supposed to be present it is easy to make a positive test. This is done by melting a small quantity of copper and adding silicon copper and the babbitt dross it is desired to test. The proportions may be, copper, 5 pounds; silicon copper, 1 ounce and babbitt, 8 ounces. The mixture is then cast into a test bar, which may be merely a strip of wood rammed up in a sand mold, because if cast in a metal ingot mold, the presence of lead cannot be detected. A sand casting, however, will be covered with a white deposit, like whitewash, and will, in addition, be full of holes, containing a whitish powder, which is due to the presence of both silicon and lead in the alloy. These two elements, therefore, cannot be used together in any brass or bronze which contains lead.



Easy Lessons in Chemistry

By CHARLES VICKERS

A LARGE amount of the heat which fuel is capable of developing is wasted in all furnaces, the losses by radiation and the escape of unconsumed gases being particularly heavy. Crucible furnaces used for melting brass and steel are exceedingly wasteful, as they are generally connected direct to the stack. The gases, therefore, pass to the open air at a high temperature, thus carrying off a large percentage of the heat developed in the furnace. Various attempts have been made to utilize this heat by carrying it into a core oven and using it to dry cores, or by setting a steam boiler in the flues, for the generation of steam to heat the building, or for power purposes. The core oven idea, however, is successful only when the furnaces are driven by blast. Both the main and branch flues of the furnace should be very large in area, and considerably greater in size than is necessary for natural draft furnaces. If the outlet from the core oven to the stack is provided with a damper, the hot gases can be diverted into the core oven flues until the fumes begin to leak into the shop, when the oven damper can be opened enough to allow them to pass into the stack and still maintain the temperature of the oven.

In this way the waste heat from the furnaces is utilized to the fullest possible extent in the core oven. It must however, be remember that the size of the oven must be proportionate to the amount of heat available, as one small furnace will not furnish heat sufficient to produce a high temperature in a large oven. When the waste heat is used for generating steam, the boiler should have a separate fire box so that it can be independently fired, otherwise, when the furnaces are not in use, there is no steam available. There is no question about the economies that can be effected by using the waste heat to generate steam in connection with the usual system of firing, and such installations have been used in brass foundries for many years.

A striking illustration of the value of the waste heat from crucible furnaces is furnished by the higher efficiency of furnaces that are equipped with hoppers or preheaters into which the cold metal is charged to be heated by the waste gases of combustion and by furnaces that heat their own blast, which result in economies such as more rapid melting and reduced fuel consumption. While the union of oxygen with carbon, as exemplified by the burning of coal, oil or gas, is at present the most practical method of generating heat, it is not the only way, as it can also be produced by friction, by resistance and by chemical means, in which carbon plays no part.

The first of these, the rubbing together of two surfaces, opens up a very interesting subject to the brass foundryman, which, at present, we will not touch upon except to state that a familiar example of heat, so generated, is furnished by the flaming oil box of a freight or passenger car. The incandescent lamp is an illustration of heat produced by the resistance of a carbon or metallic wire, or filament, to the passage of a current of electricity, which is thus converted into visible heat and so emits light, which is the purpose for which the lamp was primarily intended.

There are numerous ways in which heat can be chemically generated other than by the oxidation of carbon, and one familiar example is the burning of phosphorus, which, as is well known to foundrymen, is very easily ignited, and is another way of directing attention to its great affinity for oxygen. Sodium and potassium also easily unite with oxygen, although they will not ignite when exposed to the air. When dropped onto water, they decompose it, frequently igniting and exploding, scattering the particles of burning metal. Aluminum also possesses great affinity for oxygen and in combination with it develops intense heat. Its point of ignition, however, is very high, and it must be raised to a high temperature in contact with substances rich in oxygen before it will combine therewith. Thermit consists of aluminum in

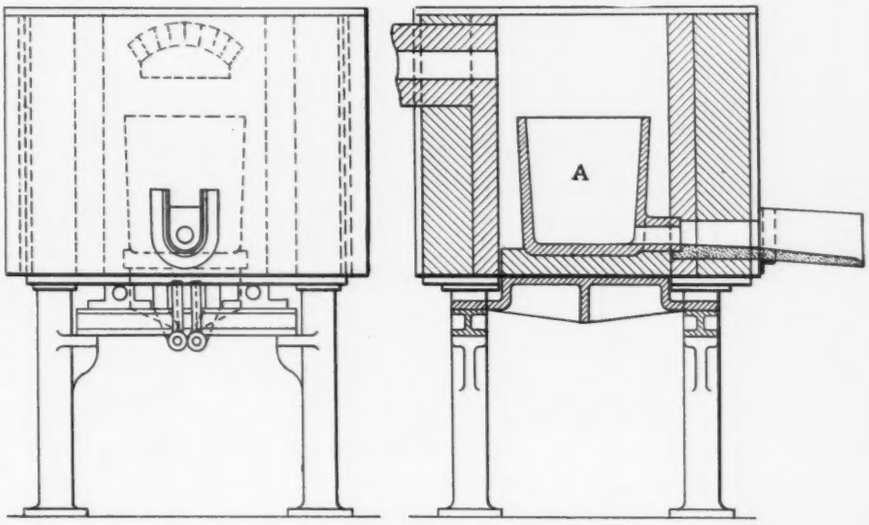
coarse powder form, mixed with iron scale, and is very easily prepared, being only a mechanical mixture of aluminum and metallic oxides. It is harmless and may be kept for years without the least danger of spontaneous combustion. In fact it is very difficult to ignite, if the proper means are not at hand, and pieces of phosphorus burned on thermit have failed to ignite it. When properly handled it furnishes a valuable means of obtaining and applying intense heat without the encumbrance of a furnace.

In the thermit reaction, as it is called, the powdered aluminum combines with the oxygen contained in the iron scale, and in so doing liberates so much heat that the iron is immediately liquefied and is raised to a high temperature. The same reaction takes place when copper scale is used in place of iron and the same is true of any metallic oxide that can be used. Therefore, this reaction furnishes a convenient means by which highly refractory metals can be obtained in the metallic condition. This is known as the alumino-thermic method, and by its use many other metals, difficult to obtain, have been placed within the reach of the foundryman. Aluminum, however, can also be used to directly melt metals when not in the form of an oxide. This application of aluminum consists of mixing the powdered metal with chemicals with which it will unite and generate heat. Copper or brass turnings are then mixed with the preparation in the proportions of 10 parts by weight of turnings to 3 parts of the mixture. Heavy pieces of brass or copper scrap are added and the mass is ignited in a crucible. A reaction, similar to that of thermit, ensues, which results in the production of hot, molten metal with a small amount of slag, that can then be poured directly into molds. In this way castings have been produced in much less time than by melting the metal in a furnace. It will be noted, therefore, that aluminum is capable of being used as a fuel to produce heat, and in this respect is more efficient than coke, gas or oil, as it generates the heat at the point where it is required, so that it is completely utilized with very little loss from radiation, etc.

The American Blower Co., Detroit, has sold a number of exhaust fans, which are used for elevating seed cotton on the estate of the Czar of Russia, located at Turkestan, Russia.

A New Brass Furnace

THE furnace shown in the accompanying illustrations is an English invention, and is interesting because it bears a great resemblance to a section of a cupola, the metal being tapped out in much the same way. It is designed to avoid the handling of crucibles, and can be used for melting large quantities of copper or bronze in crucibles. The furnace is built of firebricks encased in an iron shell, and is equipped with a spout. The shape of the crucible is shown in the section at *A*. It is bottom-poured, through a side opening fitted with a nozzle. The inside lining in front of the tap hole is recessed, and the crucible nozzle fits into this recess and is luted therein. While the furnace is working, the tap hole is plugged, and the melted metal is removed by tapping, the operation being much the same as a cupola, and either liquid, gaseous or solid fuel can be used. The furnace shown uses coke for fuel, with natural draft. It has been patented by Billington & Newton, Longport, Staffordshire, England.



FRONT ELEVATION AND CROSS-SECTION OF CRUCIBLE, METAL MELTING FURNACE

Cast Iron Liners

By N. W. Shed

Question:—The manufacture of tube mill liners in Mexico is becoming an important feature of foundry work. We have been making these liners for some of the largest mining companies. The mixture contains 70 per cent car wheels and 30 per cent steel, largely rails, I beams, steel punchings, etc. The life of these liners is approximately six months, while on the other hand, some of the mining companies operating their own foundries, claim that their liners have a life of about nine months. The only difference we can find in the mixtures, is that they use old steel shoes and dies from stamp mills, which apparently increase the life about three months. We would like to have a mixture that would increase the usefulness of our liners from six months to nine months, if possible.

Answer:—The mixture containing car wheels and steel scrap is about as hard as can be made unless white iron is used. The silicon in this mixture is about 0.50 per cent and after melting in the cupola the iron would contain about 0.35 per cent silicon. By adding 20 per cent of white iron with 50 per cent car wheels and the steel scrap, a harder mixture would be obtained and the casting, unless 2 or 3 inches thick, would be white. The manganese in the mixture might be high, which would have a tendency to soften the chill. It is advisable to keep the manganese below 0.40 per cent. The white iron is usually high in sulphur, which promotes a hard chill. For this kind of work the sulphur content could range from 0.20 to 0.25 per cent. In desperate cases, where no white iron was available, such mixtures have been hardened by throwing lumps of sulphur in the ladle while the stream of iron is running. Two pounds of sulphur to one ton of iron will have a great hardening effect. It might be advisable to obtain an analysis of the liner running nine months and to duplicate this if possible.

The Goldschmidt Thermit Co., 90 West street, New York City, is sending to the trade a handsomely illustrated catalog, describing the thermit process of rail welding.

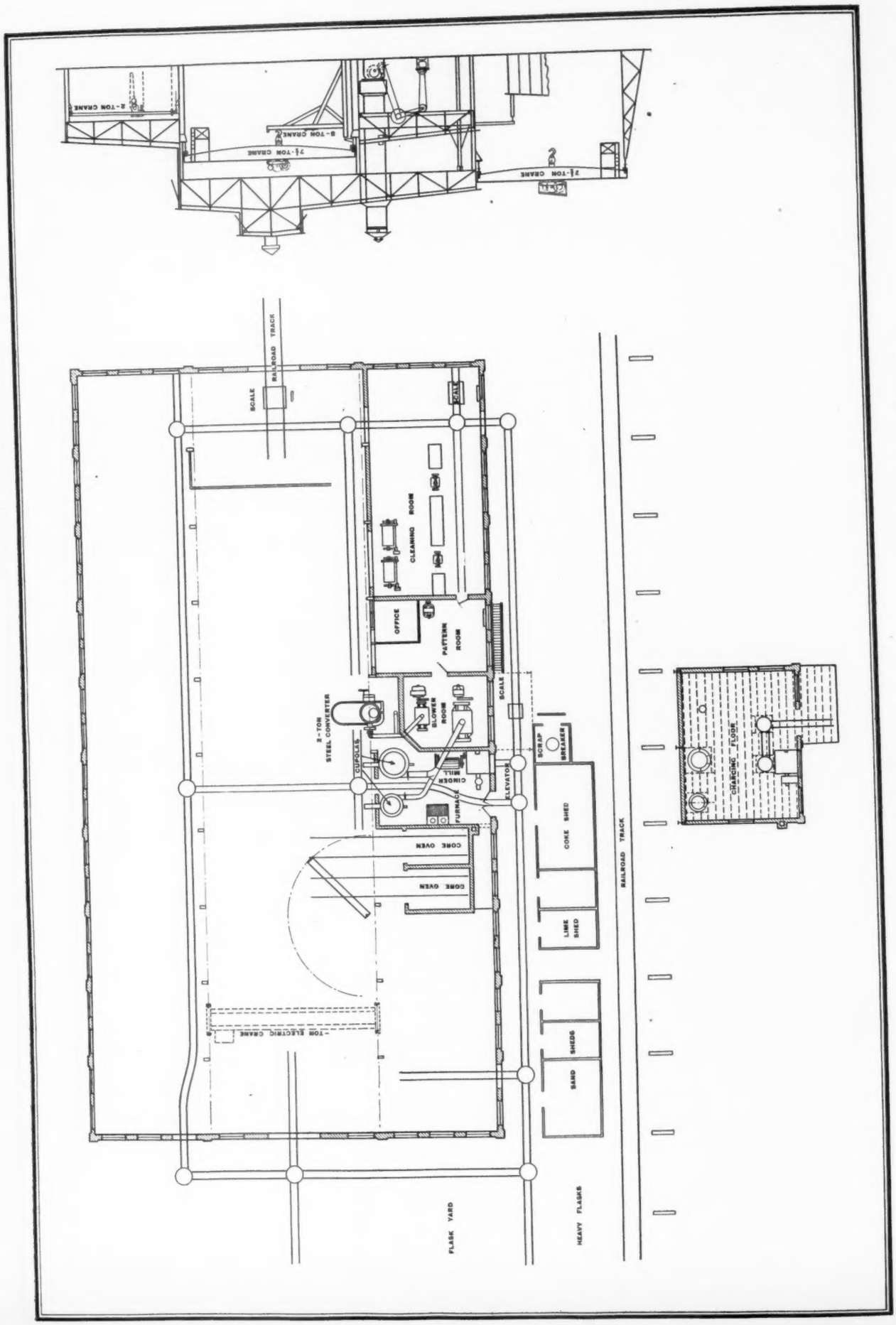


FIG. 1—GROUND PLAN AND CROSS-SECTION OF A COMBINED GRAY IRON AND STEEL FOUNDRY

TYPICAL MODERN FOUNDRY LAYOUTS--III

General arrangement and equipment of cast iron car wheel plants, combined gray iron and steel foundry and a small brass shop

THE general principles which apply in laying out a modern gray iron foundry are also valuable in designing shops such as brass foundries, steel foundries, car-wheel plants, pipe or malleable iron foundries. In these special foundries, however, certain general practices peculiar to each kind of work have arisen and have an effect in modifying the nature of the foundry layout. The layout of a special foundry involves certain standard features peculiar only to the special class of work involved A series of articles on typical modern foundry layouts should, therefore, to be complete, include a number of steel, brass, malleable, car-wheel and other foundries devoted to special work. In this article a typical combination gray iron and steel foundry of 30 tons daily capacity will be described and two car-wheel foundries with a capacity of 250 and 600 wheels per day, respectively, will be shown, together with the layout of a brass foundry having a capacity of 2,000 pounds per day.

Third of a series of articles describing modern foundry layouts. For the designs, illustrated herewith, we are indebted to the Whiting Foundry Equipment Co., Harvey, Ill.

Combination Iron and Steel Foundry.

The combination gray iron and steel foundry, Fig. 1, is housed in a steel frame building consisting of a main bay and a side bay, the latter being opposite the cupolas and melting furnaces. The building is 200 feet in length and 104 feet in width. The width of the main bay is 82 feet, and the side bay 32 feet. As is shown in the accompanying plans, a space 32 feet wide in the main bay, is taken up by the cupola, steel furnace, core ovens and other machinery, leaving a molding floor, 200 x 82 feet in size, with an area of 16,400 square feet. This plant is equipped with two cupolas, 42 and 54 inches in diameter inside of lining, respectively. The cupolas are located in an enclosed room and are situated at about the middle of the foundry floor. On one side of the cupolas is a 2-ton Bessemer steel converter and on the other side are the two core ovens. The core oven fire pits are located in the cupola room. The dimensions of the two core ovens are, respectively, as follows: Eighteen feet long, 9 feet 6 inches wide and 7 feet in height and 18 feet long, 11 feet wide by 7 feet in height. Each core oven is provided with the usual track and car. In front of the core ovens is a jib crane having a radius of 25 feet. This crane is used to handle heavy cores to and from the oven cars. The coremaking department is in a corner of the shop near the core ovens.

Industrial Railway.

The molding floor, cupola room, cleaning room, flask yard, material yard, etc., are all connected by an industrial railway. The material yard is spanned by a 7½-ton electric

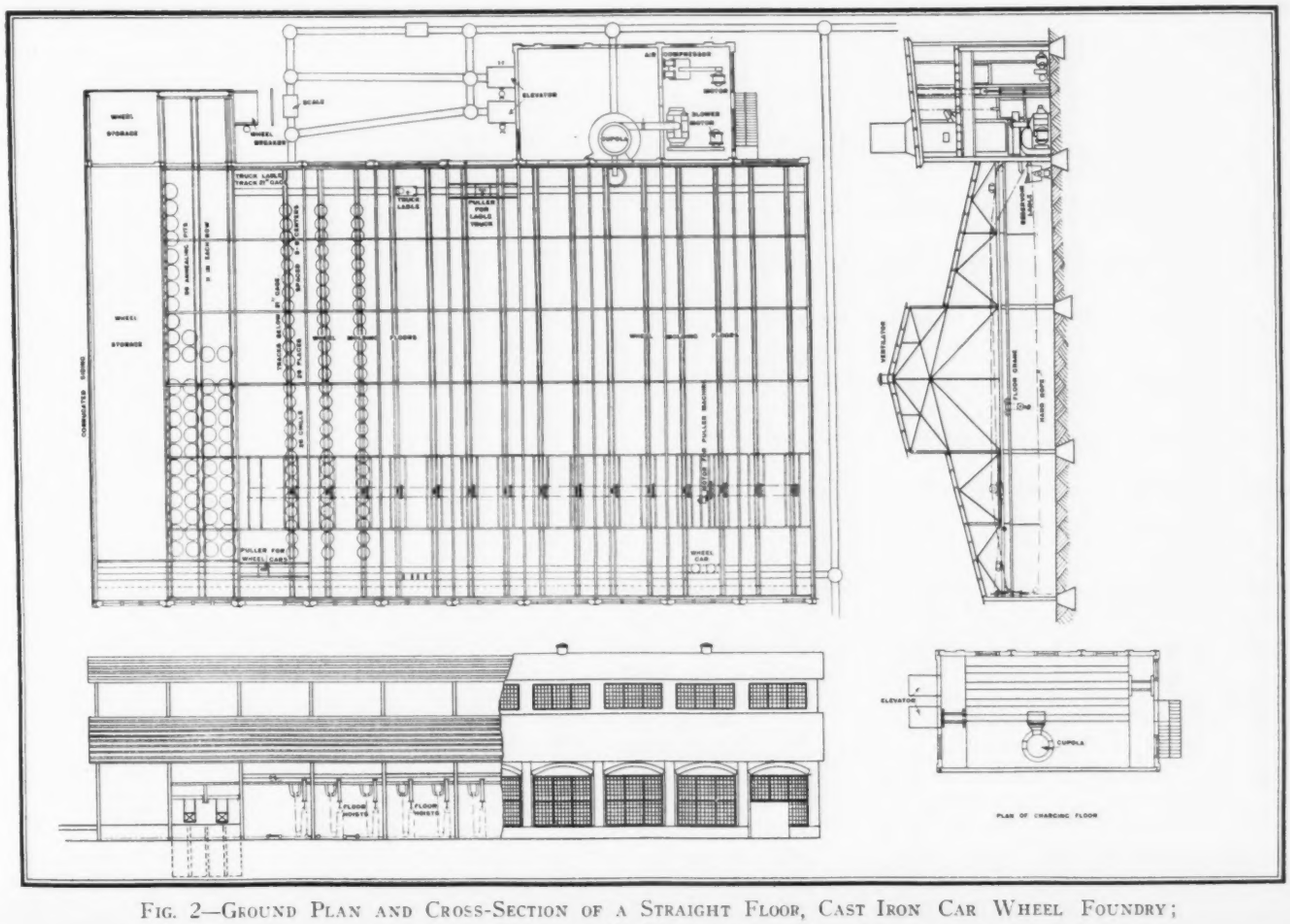


FIG. 2—GROUND PLAN AND CROSS-SECTION OF A STRAIGHT FLOOR, CAST IRON CAR WHEEL FOUNDRY; CAPACITY, 350 WHEELS PER DAY

FIG. 1—GROUND PLAN AND CROSS

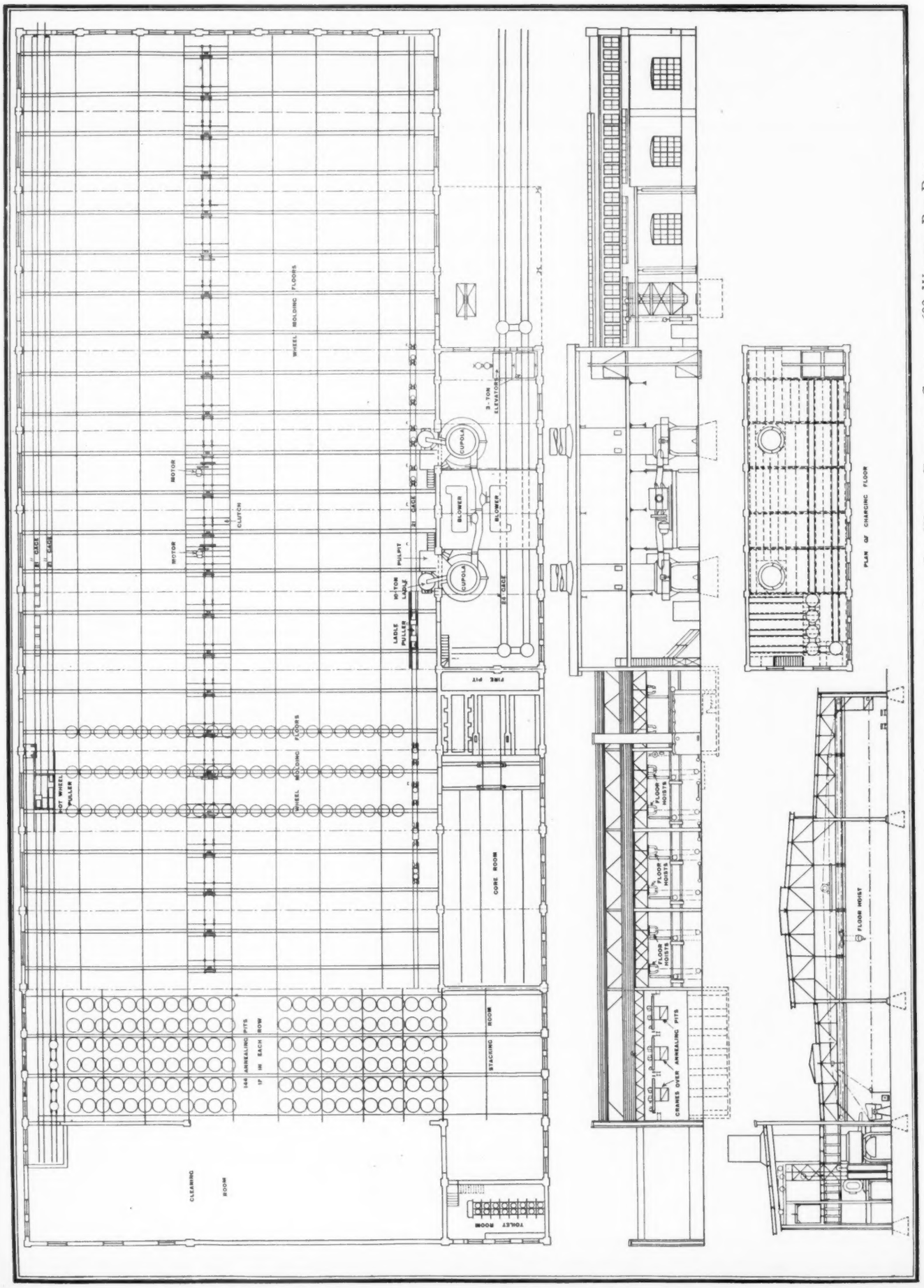


FIG. 3—GROUND PLAN AND CROSS-SECTION OF A STRAIGHT FLOOR, CAST IRON CAR WHEEL FOUNDRY; CAPACITY, 600 WHEELS PER DAY

traveling crane, One rail of the crane runway is supported on brackets riveted to the building columns and the other rail is supported on structural steel towers. The main bay of the foundry is served by a 7½-ton electric traveling crane having a span of 50 feet, and the side bay is served by a light, hand-operated 2-ton crane.

The cupolas and the steel converter are placed close together so that hot metal may be quickly transferred from the cupolas to the converter. The blast for the cupolas is provided by a positive pressure blower and the blast for the converter is furnished by a separate blower. Between the blower room and the cleaning room is a room devoted to the temporary storage of patterns. The foundry foreman's office is situated in this room and is separated from the pattern storage space by a glass partition.

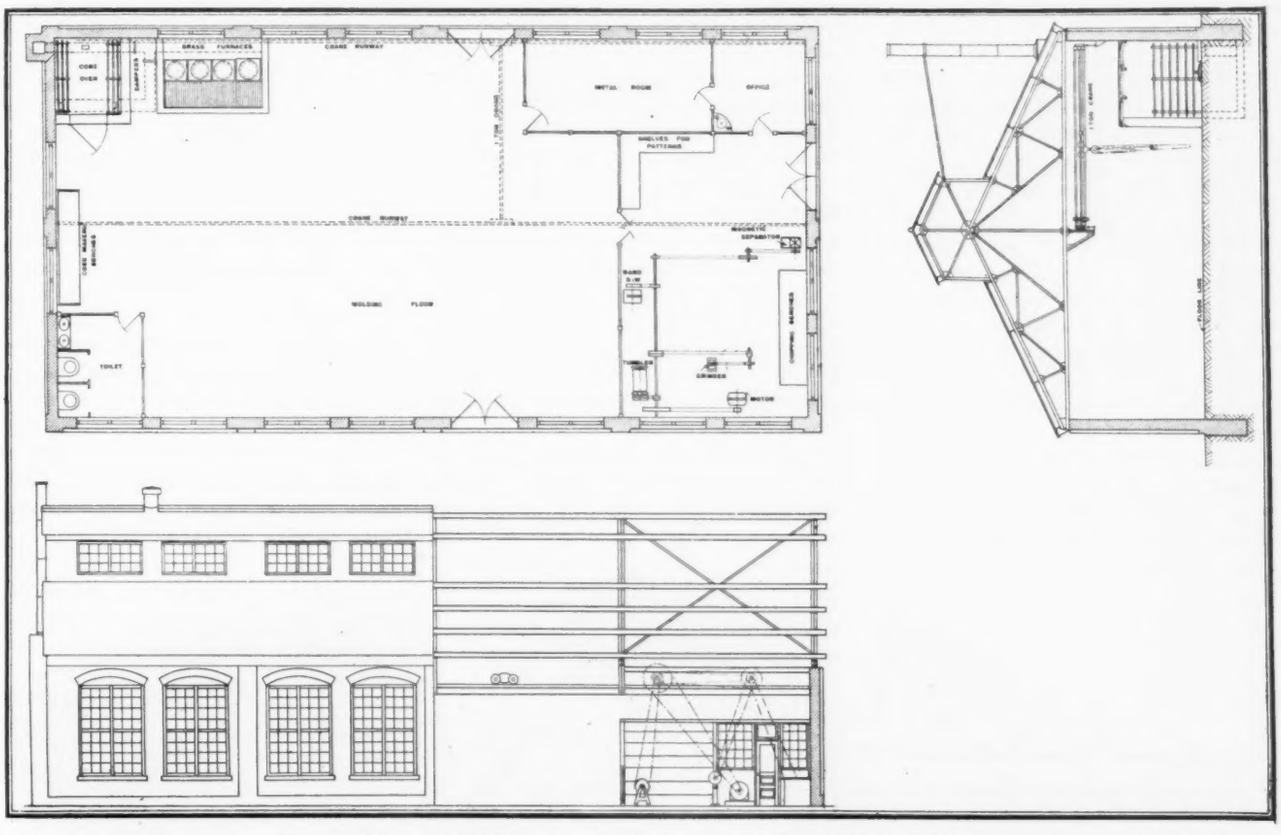


FIG. 4—GROUND PLAN AND CROSS-SECTION OF A SMALL BRASS FOUNDRY

FIG. 3—GROUND PLAN AND CROSS-SECTION OF A STANDARD CAR-WHEEL FOUNDRY

Car Wheel Foundries.

The two wheel foundries, Figs. 2 and 3, are laid out on the modern, straight floor plan, the buildings consisting of a single main bay covering the molding floor and a side bay occupied by the cupolas, core rooms and auxiliary machinery. The 350-wheel foundry is provided with one cupola, 78 inches in diameter inside of lining, the blast for which is furnished by a large blower. The arrangements in this foundry for handling material are very carefully worked out. The charging floor is provided with two elevators, and the plant is equipped with the usual industrial railway in addition to the special floor cranes running on I-beam trolleys, according to the usual practice in modern car-wheel plants. The molten metal is distributed in truck ladles running on a 21-inch gage track. The cranes and ladles are operated by electric-driven pulling machines. The cleaning room and wheel storage departments are located at the end of the molding floor.

The 600-wheel plant is provided with two cupolas, each 78 inches in diameter inside of lining. The blast for each cupola is provided by a positive pressure blower. The blowers are so arranged that either one may be used with either cupola. In this plant, 10-ton stationary ladles are placed in front of each cupola, from which the truck ladles are filled. The charging floor is served by two 3-ton hydraulic elevators, the platform of each elevator being 6 x 8 feet. Three core ovens are installed, as shown in Fig. 3.

Attention is directed to the height of the charging floors in the three plants described. In the two car-wheel foundries the charging floor for the 78-inch cupolas is 25 feet above the ground. In the combination gray iron and steel foundry the charging floor is 18 feet above the ground. Some careful investigations have been made by the designers of these plants and the conclusion has been reached that there is a definite relation between the height of the charging floor and the fuel ratio of the cupola. If the charging door is too low it is very uncomfortable for the cupola tender on account of the flames coming out through the door every time it is opened. This also results in a considerable waste of heat. If the charging door is too high there is also a detrimental effect, due to the heavy charge destroying the blast pressure by offering too much resistance to the passage of the air. If, however, the door is placed at the proper height, the blast pressure is properly maintained and the heat is efficiently absorbed by the charges.

Brass Foundry.

The brass foundry illustrated in Fig. 4, is housed in a small, steel frame building, with brick walls, 80 x 40 feet in size. Along one side of the molding floor are situated the core

oven, brass melting furnaces, metal storage room and offices. This portion of the floor is served by a 1-ton, light traveling crane having a span of 20 feet. The core oven is 8 feet long, 7 feet wide and 8 feet in height. The brass furnaces are of the pit type, four in number, and occupy a space 11 x 8 feet.

The metal storage room is partitioned off from the main molding floor and is 10 x 20 feet. Adjacent to the metal storage room, in a corner of the building, is the office, 10 feet square. The cleaning, grinding and shipping departments are situated at one end of the building in a room, 30 x 20 feet, which is separated from the molding floor by a light partition. A corner in this room is fitted up with shelves for storing patterns. The cleaning room is provided with a band saw, tumbler, grinder and a magnetic separator, all operated with a single electric motor by means of the usual arrangement of belts and shafting. This shop is designed entirely for the production of brass castings and has a capacity of approximately 2,000 pounds per day.

Molding Thin, Deep Castings on a Jolt-Ramming Molding Machine

THAT the jolt-ramming machine is well adapted for molding thin, deep work, such as boiler sections, ash pits, large man-holes, etc., is indicated by the success achieved on this class of work by the Turner & Seymour Mfg. Co., Torrington, Conn.

The machine in use in the foundry operated by this concern is of the plain, jolt-ramming type, having an 18-inch cylinder and a lifting capacity of 10,000 pounds. The table is 42 x 66 inches and the machine was installed by the Osborn Mfg. Co., Cleveland. In Fig. 1 is shown the drag half of a mold for a hot water heater dome casting. The flask is 3 feet, 6 inches square, and the domes vary in weight from 200 to 500 pounds. Four green sand cores, 10 inches high, are shown, and no difficulty is experienced in ramming these on a machine of this type. The cope, which is also jolt-rammed, is shown in the background and a dry sand body core is set over the four green sand cores before closing. The metal thickness is only ¼ inch and the weight of the mold is approximately 3,000 pounds. The great economy effected by the use of the jolt-ramming machine is shown by the increase in the daily output. When molded on the floor by hand, the record daily output for a molder and helper was four molds per day. By the use of a machine a molder and helper now produce from nine to twelve castings and the losses likewise have been greatly reduced.

In Fig. 2 is shown the cope part of a mold for a large ash pit molded in a three-part flask. The casting weighs approximately 70 pounds and the metal thickness is slightly less than ¼ inch. Fig. 3 shows the drag part of a mold after ramming on the jolt-ramming molding machine before rolling over and drawing the pattern. The drag carries a green sand core approximately 15 inches deep, which cores out the center of this casting. The cheek, which closes over the

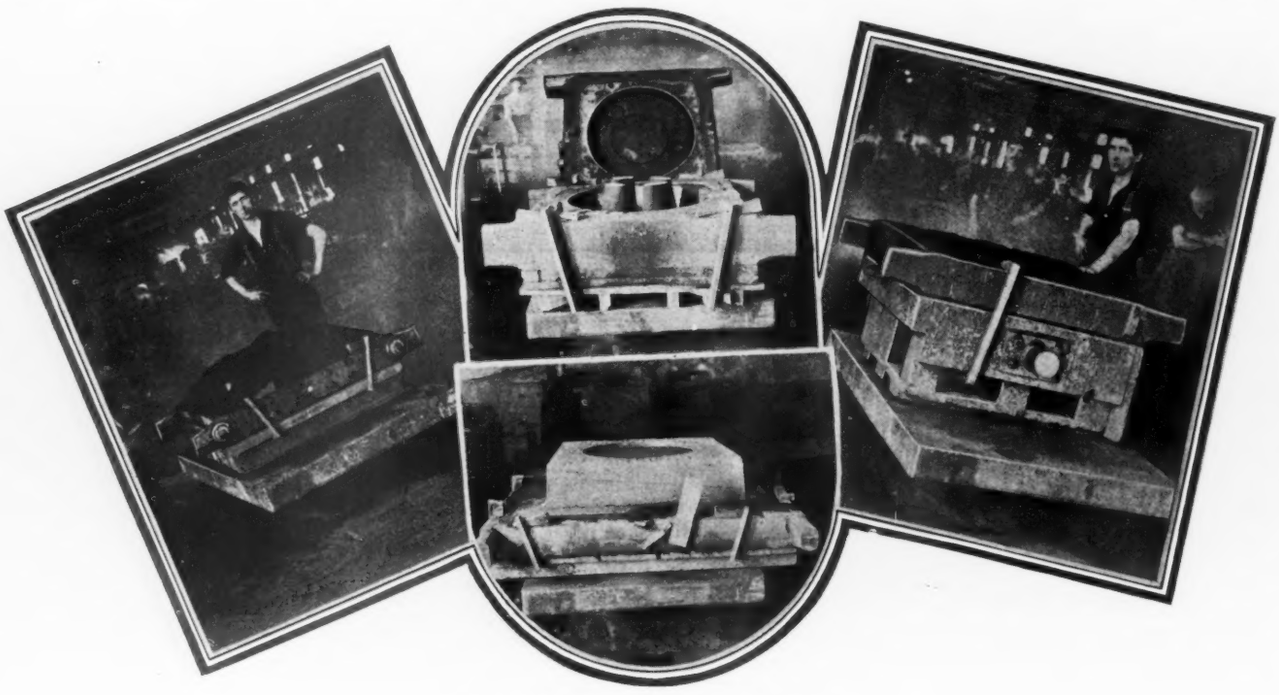


FIG. 2—COPE HALF OF ASH PIT MOLD

FIG. 1—DRAG HALF OF MOLD FOR A HOT WATER HEATER DOME CASTING

FIG. 4—DRAG HALF OF MOLD FOR A LARGE CATCH BASIN CASTING

FIG. 3—DRAG HALF OF MOLD AFTER RAMMING AND BEFORE ROLLING OVER

green sand core, is likewise jolt-rammed. The cope carries only a small part of the pattern and is more in the nature of a covering for the mold. The daily output, when jolt-ramming these molds, averages from nine to twelve for a molder and helper.

The drag half of a mold for a large catch basin with the pattern still in place is shown in Fig. 4. The opening in this catch basin, which is formed by green sand cores, is 2 feet in diameter. In addition this opening is flanged. It will also be noted that the flask is considerably larger than the table of the machine. In Fig. 5 are shown some of the hot water boiler sections, as well as several of the large ash pits cast in molds made on this jolt-ramming machine.

FIG. 5—HOT WATER BOILER SECTION AND LARGE ASH PITS MOLDED ON A JOLT-RAMMING MOLDING MACHINE

Reproducing a Casting at Small Expense

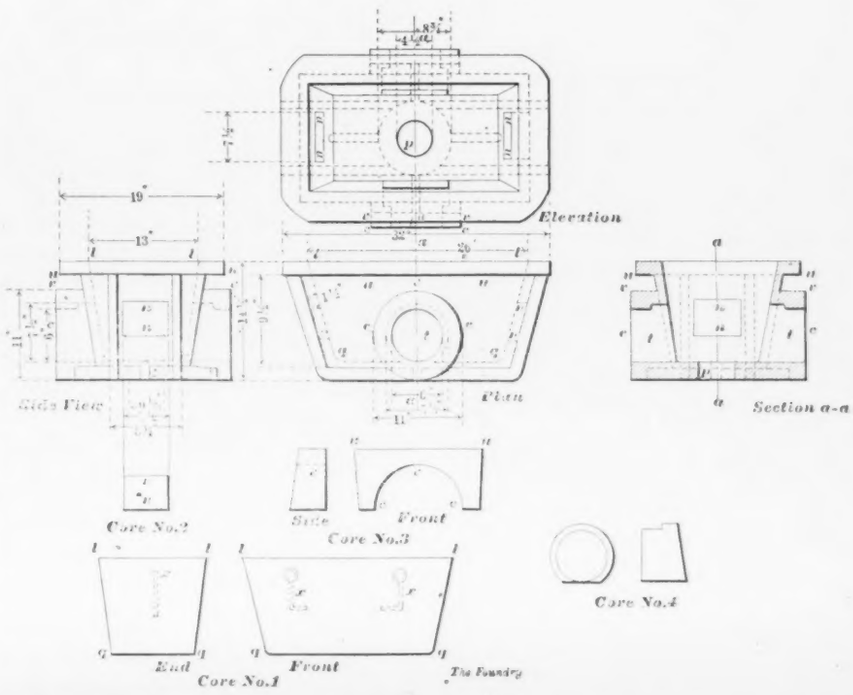
By B. Baxter

JOBBING foundries have many difficulties to contend with, and a large portion of their work is of such a character that it cannot be molded to the best advantage, as the best of patterns are not always furnished. Frequently, broken castings are received and are the only models from which the castings are to be made. In many instances it is more economical to use the old casting as a pattern.

A casting recently ordered, and which was required for immediate repairs, is shown in the accompanying illustration. The casting was molded in a flask 25 x 38 inches, and the drag and upsets added to increase its depth, the depth of this half of the mold being 18 inches. The pattern was placed on a board and the cores placed in position. The two cores, *n n*, were set in the ends level with the pattern surface, and cores No. 4 were set inside of the hubs at *t t*. The two cores No. 3 were set around the hub and under the flange, fitting at the points marked *u u v* and *c c*. A 6-inch stock core was used for the opening at P. Core No. 1 was set inside of the pattern to keep the other cores in position while the drag was being rammed. After the drag was rolled over, the cope flask was adjusted and two pieces of wood, 2 inches wide, were placed across the top of the cope. Wires were passed through the eyes of the lifting rods, *x x*, in core No. 1, and these were securely fastened around the two pieces of wood on top of the cope. The latter was then rammed and the cope, together with core No. 1, were lifted off. The two small bodies of sand over cores No. 3 at *u u* were cut away to provide clearance for the cores and hub while drawing the pattern. The pattern was then lifted out and all cores, except the stock core P, were lifted out with the pattern. The mold was then finished and the cores set in position and sufficiently secured. The sand which was cut away from cores No. 3 at *u u* was returned by the use of a straight edge. The weight of this casting was 675 pounds, and the time of molding was 10 hours, that is, two molders five hours each, and coremaking, seven hours. Considering the difficulties involved in making this casting, it is believed that the cost of producing the same could not greatly have been reduced.

FOUNDRY SUPPLY ASSOCIATION DISSOLVED.

C. E. Hoyt, secretary of the Foundry and Manufacturers' Supply Association, Lewis Institute, Chicago, in an announcement to the members, states that there was a practically unanimous vote in favor of the resolution adopted at Pittsburg to dissolve this organization. The exhibits of foundry equipment and supplies in connection with the foundrymen's convention, which will next year be held in Pittsburg, will hereafter be conducted by the Foundry and Machine Exhibition Co. The affairs of the Foundry and Manufacturers' Supply Association will immediately be closed and the balance on hand will be pro-rated among the members.



PLAN, ELEVATION AND SECTIONS OF CASTING; THE CORES ARE ALSO SHOWN

THE FOUNDRY

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Trade Outlook

As the result of the slight improvement in the iron and steel trade, a better feeling prevails in the foundry industry and the outlook for the future is brighter than it has been at any time this year. The railroads continue to buy sparingly and to cover immediate needs only, but the tonnage, in the aggregate, is considerable and the heavy steel casting shops have increased their melt, to some extent, during the month. There is a dearth of repair work from the rolling mills, and foundries specializing on heavy work for steel works' equipment report only a small tonnage on hand. The gray iron jobbing shops continue to operate on short time, although reports from all sections of the country are to the effect that many idle foundries are resuming operations. In the malleable trade, the shops that are dependent upon the agricultural implement manufacturers for their tonnage are operating at capacity, and many plants will establish new output records during the current year. The heavy sales of farm implements reflect the prosperity of the rural communities and the bumper crops insure another good year for the many manufacturers who make a specialty of farm equipment. The fact that the railroads are already closing contracts for their 1911 rail requirements would indicate that they will soon place orders for both passenger and freight cars. How extensive the car orders will be cannot be conjectured at this time, but it is certain that the new rolling stock requirements, as well as the replacements of old cars, will be twice as large as during the current year. Reports from Detroit indicate a resumption of activity in the automobile industry during the winter months, but operations will be on a more conservative basis and the output of cars for the 1911 season will be materially restricted. As yet, the brass shops have received only small orders from the automobile manufacturers and the indications are that contracts will be placed covering only a few months' requirements, in place of an entire season, which has been the practice heretofore. Steel foundries, equipped for producing only light work, report little new business and many crucible steel casting shops in the Milwaukee and eastern Pennsylvania districts are idle and there are no favorable prospects that would point to an early resumption of operations. The pig iron market is stronger and there has been considerable buying through the first half of next year. Basic iron has been advanced in price, while in the south the blast furnace operators are inclined to hold No. 2 foundry at an advance of 50 cents over prevailing quotations, for deliveries extending into 1911. In the leading manufacturing centers No. 2 foundry iron is quoted as follows: Local, Chicago, $16; southern, Cincinnati, $14.25; northern, Pittsburg, $14.90; standard, eastern Pennsylvania, $15.75; southern, Birmingham, $11, and local, Cleveland $14.25. Lake Superior charcoal iron is quoted at $18, Chicago, and basic at $14.65 Pittsburg.

The Foundry Engineer

For many years, the metallurgical problems of the foundry industry have been under investigation by skilled engineers, and as a result of their experiments and research, the progress made in the art of founding during the last quarter century, is largely due. Many of the vexatious difficulties resulting from the improper mixing and melting of metals have been overcome by the foundrymen who have followed the advice of the metallurgists, and the behavior of cast iron, steel and brass, under varying conditions, is no longer enshrouded in mystery. Until recent years, however, the tools of the foundryman have received little consideration, and plant arrangement and equipment problems were not attacked with any degree of zeal, nor with a desire to effect great economies in operation. Traditional practice either prevented or restricted the adoption of methods that would facilitate molding and the subsequent handling and cleaning of castings, and, sad to relate, in many shops today, a deaf ear is turned to suggestion for the improvement of the mechanical equipment. Yet, notwithstanding this opposition, it is doubtful if any line of manufacture has made greater strides in the adoption of labor-saving devices, over a span of a comparatively few years, than the foundry industry, and the resulting low producing cost is the compelling factor that will lead to the reconstruction of many shops where traditional methods have not yet been supplanted by modern practice. To the foundry engineer must be accredited the improvement in plant layout as well as a large part of the labor-saving equipment now used, and upon him, in large measure, the foundry trade is dependent for future progress along these lines. The introduction of the engineer in the foundry is a comparatively recent innovation, but the permanency of his position, not only in an advisory, but constructive capacity as well, is already assured. The skill of the foundry engineer is reflected in many

casting plants recently built, and few projects of any magnitude are now undertaken without calling him into consultation.

Personal

R. B. Farquhar Jr. has been chosen general manager of the Keystone Steel Casting Co., Chester, Pa., succeeding D. C. Egan, resigned. Mr. Farquhar was for some years in the employ of the Taylor Iron & Steel Co.

A. E. Domville, superintendent of foundries of the American Car & Foundry Co., Berwick, Pa., has resigned and after Dec. 1 will be affiliated with the Nevius Castings Co., Philadelphia, in which he has purchased a large interest.

John A. Logan, formerly foreman of the brass foundry of the National Cash Register Co., Dayton, O., has assumed the position of foreman of the aluminum and brass foundry operated by the Fairview Foundry Co., Detroit.

The Harbison-Walker Refractories Co., Pittsburg, manufacturer of fire brick, fire clay and a complete line of refractory products for iron and steel works and foundry use, has announced the appointment of Kenneth Seaver to the position of chief engineer.

Col. Charles M. Jarvis, first vice president of the American Hardware Co., New Britain, Conn., has been elected president to succeed the late Philip Corbin. Charles H. Parsons, second vice president of the American Hardware Corporation, has been elected first vice president.

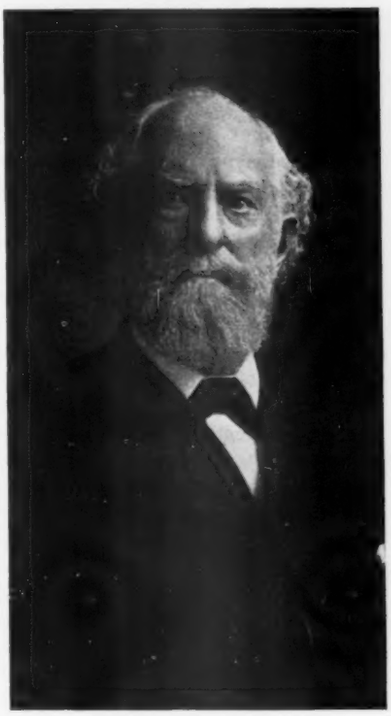
The Rockwell Furnace Co., 26 Cortlandt street, New York City, has acquired the exclusive right to manufacture and sell the Moyer tramrail. A. W. Moyer will hereafter be associated with this concern in the capacity of manager of its foundry equipment department, in which will be included melting furnaces, core ovens and overhead foundry tramrail systems.

Walter Brinton, superintendent of the manganese steel department of the Taylor Iron & Steel Co.'s plant, High Bridge, N. J., has resigned and has accepted a position as consulting engineer of the Edgar Allen American Manganese Steel Co. This concern produces manganese steel at Chicago Heights, Ill., and at New Castle, Del., and Mr. Brinton's headquarters will be at the latter plant.

Pettinos Bros., South Bethlehem, Pa., announce the removal of their Philadelphia warehouse from 1536 Callowhill street to 2011 Market street.

Death of Philip Corbin

Philip Corbin, president of the American Hardware Corporation and one of the leading manufacturers of the United States, died at his home in New Britain, Conn., Nov. 3, after an illness that had extended over the past two years. He was in his eighty-seventh year, and 60 years of his life were spent in active business, the success of which is reflected in the fact that as president of the American Hardware Corporation, he was, at the time of his death, the head of one of the largest manufacturers of builders' hardware in the world. Mr. Corbin's



PHILIP CORBIN

life was devoted constantly to the principle of hard work and persistent application to business. Starting under the most unpretentious circumstances, he developed a manufacturing enterprise of great proportions and of wide influence. From a capital of $900 invested in a small plant, the business grew to a corporation capitalized at $10,000,000, and employing 6,000 men.

Mr. Corbin was born in Willington, Conn., on Oct. 26, 1824, and the early years of his life were spent in a brief schooling and in farming near his native town. At the age of 20 he went to New Britain, where he secured employment in the hardware factory of Matteson, Russell & Co. Though his compensation was small, he not only provided for his own needs but regularly sent home a small amount to his parents. One year later a lock-making contract given him by his employers, North & Stanley, launched him upon his manufacturing career. This beginning gave him the conviction that in this direction there was opportunity for his advancement in a broader way and it paved the way for the formation in the summer of 1848 of the co-partnership of Doen, Corbin & Co., including his brother Frank, and Edward Doen, for the purpose of manufacturing hardware. Each of the three young men contributed $300 to the capital and $600 of this sum was expended for land and a building. On Sept. 1, 1849, Henry W. Whiting, father-in-law of Mr. Corbin, bought Mr. Doen's interest and two years later he sold his share in the business to the two Corbin brothers. The firm then became P. & F. Corbin, the name under which the business is carried on at present.

In 1851, American manufacture was in its infancy, and nearly all the hardware was imported. Mr. Corbin avoided domestic competition by confining his product to articles made abroad, and as they were better made than the imported goods he found a ready market. In 1852, the business had outgrown its original quarters and Mr. Corbin secured a room in the factory of North & Stanley on the present plant of P. & F. Corbin. Additional room was soon engaged and the old factory abandoned.

Mr. Corbin was quick to appreciate any opportunity for the expansion of his business, and in the first five years of its life added to its many new articles. It soon became apparent, however, that the limited capital of the firm closed to it many avenues for extension and in 1854 it was decided to form a corporation and allow others to purchase stock in order that money might be secured to invest in additional equipment. This was done on Feb. 14, 1854. Mr. Corbin was made secretary of the company and continued in active charge of the operations. In 1859, he was made treasurer, and was made president at the death of F. H. North, who was one of the new stockholders at the time of the incorporation and the company's first president.

In 1858, Andrew Corbin joined his brother. In 1860, he assumed charge of the New York office, and in 1872 returned to New Britain to become general manager of the factory and its first vice president. So closely did his life become identified with that of his brother that no account of Philip Corbin's career from this time on would be complete without mention

of Andrew. While each had his own field of effort, and that of Andrew was subordinate to that of Philip, the two brothers acted in concert and in perfect accord in all things. Philip was for the first time freed from the detail of the production and enabled to devote to the management of the business the rare administrative qualities which he possessed, while the quickening and masterful influence of Andrew's genius permeated the factory. Andrew Corbin died on Jan. 4, 1907.

In 1882, Mr. Corbin decided that the manufacture of cabinet locks could be better conducted as a separate industry than as one of the lines of P. & F. Corbin's goods, and the Corbin Cabinet Lock Co. was accordingly formed. This company's welfare was always a matter of special concern to Mr. Corbin, and its rapid growth and prosperity were a source of much satisfaction to him.

The creation of the American Hardware Corporation was a striking indication of the popular appreciation of Philip Corbin's business ability and judgment. Difficulties which another man would have found unsurmountable, disappeared before the influence of Mr. Corbin's prestige, and the holders of every share of stock in the two companies assented to the change when the American Hardware Corporation was formed on March 13, 1902, with Philip Corbin as president. While other honors and successes had come to him more or less directly as a result of his ability and reputation, the American Hardware Corporation, made possible only by the universal recognition of Mr. Corbin's sterling qualities, stands peculiarly as a tribute to his genius and high personal worth.

On May 2, 1903, the Corbin Screw Corporation was formed to manufacture screws and screw machine products. On June 11, 1903, the manufacture of automobiles having been favorably considered, the Corbin Motor Vehicle Corporation was incorporated.

In politics, Mr. Corbin enacted the part of a good citizen, using his influence to further the welfare of his city and state, but not seeking office. He served as burgess of the borough for one term, to secure justice; was a member of the common council; subsequently as water commissioner he supervised the enlargement of the system which has given the city its splendid supply. In 1884 he was elected a member of the Connecticut state legislature and in 1888 a member of the state senate.

Book Reviews

Self-Taught Mechanical Drawing and Elementary Machine Design.—By F. L. Sylvester, M. E.; 5 x 7½ inches, 330 pages, illustrated. Supplied by THE FOUNDRY, for $2.

This work is an elementary treatise on mechanical drawing and the first principles of machine design, adapted to the requirements of the young mechanic and draftsman whose theoretical knowledge is limited. The first chapter describes the instruments and materials necessary, and how to select, to use and keep them in proper shape. Other chapters are devoted to the definition of terms used in geometrical and mechanical drawing, geometrical problems and projection, the language used being simple and clear, leading the student by easy stages from the elementary definition of a point, to isometric projection, in such a manner that the information can be self-acquired. The knowledge thus gained paves the way for the chapters on working drawings, which first explain the object of a drawing, then follow with examples of working drawings of many different parts of machinery, screw threads, etc., as well as charts showing cross sections and "broken" drawings.

A number of chapters are also devoted to machine design, elements of mechanics, strength of materials, cams, sprocket wheels, general principles of gearing and how to calculate their dimensions, shafts, belts and pulleys, and how to find the horsepower they will transmit, etc. This little book will be found very useful by ambitious mechanics, as it imparts the kind of knowledge they will find most valuable and necessary to advancement, in a clear and concise manner.

Taschenbuch fur Eisenhuttenleute. (Pocket-book for iron and steel metallurgists)—Written by forty-seven specialists of the Akademischer Verein Hutte; 4½ x 7 inches, 946 pages, 610 illustrations. Published by Wilhelm Ernst & Son, Berlin. Price in cloth, 15 marks; in leather, 16 marks.

This work is divided into five sections and an appendix. Each section has numerous subdivisions and the first, which contains 283 pages, is educational and leads to a better comprehension of the rest of the book. It treats of chemistry, mineralogy, metallography, the laws of freezing and cooling, etc., and includes tables of reference of the physical properties of the metals and various chemical bodies connected therewith. The second section is devoted to fuel, and treats of the different kinds, the laws of combustion and furnace materials. Pages 335 to 342 are devoted to a description of gas producers, and include a number of illustrations. The last article of this section treats of the manufacture of coke and describes a number of different systems, the subject being well treated. The third section treats of machines and by-products, the first subdivision being devoted to boilers, which is followed by engines, both steam and gas, piston and turbine, and also electrical machinery. The fourth section takes up iron and steel production and foundry practice and also treats of the manufacture of pig iron and wrought iron, explaining the Bessemer, open-hearth and crucible processes, and the electric furnace. Section five treats of rolling mill practice in an exhaustive manner and has numerous subdivisions containing valuable data. The book will be found useful and instructive by those interested in the metallurgy of iron and steel.

American Producer Gas Practice.—By Nisbet Latta; 7½ x 10½ inches, 539 pages, 247 illustrations. Furnished by THE FOUNDRY for $6.

In this work strictly scientific and technical language has been avoided as much as possible, and the modern every-day operation of producer gas engineering practice is presented in a simple style that makes it easy to comprehend by those interested in this subject. It treats first of producer operation, the effects of steam on the quality and quantity of gas and the materials required in the construction of producers, together with their repairs and maintenance, with formulas for groutings, cements and putties.

The chapter on cleaning gas describes the various scrubbers, dust and moisture determinators, centrifugal gas washers, etc., with instructions for first aid in case of asphyxiation from inhaling carbon monoxide. The different types of producers are illustrated and described, and the history, heat values and comparative costs of solid fuels, with their analyses, and that of the gases evolved therefrom, are exhaustively dealt with. Succeeding chapters on industrial gas applications, furnaces and kilns, describe the various burners in use and their method of application to forges, ovens, steam boilers, billet heating, crucible, and non-crucible furnaces, as well as kilns for burning lime and cement. The entire subject of the man-

ufacture and application of producer gas is well covered, and extends to the efficiency of open-hearth furnaces, their design and the combustion that occurs therein. Under the headings of heat, temperature, radiation, and conduction, are given tables of the boiling points of various substances, the melting points and composition of alloys, the temperatures of steel melting operations, metal tempering baths, and metallurgical working temperatures, etc.

The chapter on heat measurements treats of pyrometry and calorimetry, and describes the various types of apparatus in use and method of application. The size of pipes required for gas is given, with tables of capacity, and loss by friction, also formulas for calculating the height of chimneys, etc. An appendix is devoted to oil fuel producer gas, with illustrations of the various apparatus used and a description and analysis of different oils.

Birmingham Foundrymen's Association

An interesting program of papers has been outlined for the 1910-1911 sessions of the Birmingham (Eng.) branch of the British Foundrymen's Association. The papers to be presented follow:

Dec. 10, "Foundry Difficulties."

Jan. 28, "Manganese in Cast Iron," by H. I. Coe.

Feb. 25, "The Manufacture of Foundry Coke, Past and Present," by S. W. B. Stephen.

March 25. "Some Alloys of Aluminum," by F. C. A. H. Lantsberry.

April 22, "Some Impressions of Continental Foundry Practice," by J. Shaw.

May 6, annual meeting.

May 27, "The Mechanism of the Production of Malleable Castings," by D. M. Levy.

In addition, a series of interesting visits to various works in the Birmingham, Eng., district has been arranged.

Babbitt Metal

Question:—We would like to have some information regarding the effect of silicon on babbitt metals. One suggestion is to add it in the shape of 10 per cent silicon-copper in the usual manner.

Answer:—You will find silicon to be a very injurious addition to your babbitt and we advise that you abandon the idea of using silicon-copper in this connection, as it will thicken the alloy and cause excessive dross, producing a dead, grayish surface on the ingot, which is very displeasing.

Zirconia Sand

ZIRCONIUM is at present a rare metal. It is similar to, but more basic in character, than titanium and is occasionally found in the form of a precious stone called hyacinth. Its oxide is highly infusible and can now be obtained from Brazil in the form of a sand, containing from 85 to 95 per cent of zirconium oxide. Owing to its refractoriness, this sand forms an excellent material for crucibles and has been used in the proportion of 9 parts of sand to 1 part of magnesia. It is necessary to use a binder, as these materials do not possess any adhesive properties of their own, and 10 per cent of phosphoric acid has been found satisfactory in this respect.

These crucibles are said to possess extraordinary resistance to sudden changes of temperature and to be practically unaffected by molten alkalies. Although it is highly improbable that crucibles of zirconia sand will ever displace plumbago crucibles for ordinary use, there is a possibility that it might prove of value as a constituent thereof. Metallic zirconium has been prepared in the form of a crystalline powder and is noted for its hardness, high fusing point, lack of luster and the difficulty with which it is oxidized. It is obtained in much the same way as silicon, to which it possesses many points of similarity, and as zirconia sand is comparatively cheap, the cost of the metal should not be prohibitive. If it is found to possess properties valuable in foundry metallurgy, zirconium may ultimately become as familiar to the foundryman as silicon, titanium and vanadium.

Limestone as a Flux

By W. J. Keep

Question:—Kindly advise us what quality of limestone should be used in a cupola, 48 inches in diameter inside of the lining, melting about 40 tons a day. If more than the quantity you state is used, what will be the effect on the castings?

Answer:—The quality of the limestone determines the quantity to use. The only portion of the limestone that does any good is the lime which it contains. A white limestone from near the surface of the ground frequently contains 80 per cent of lime, while that taken from any considerable depth in a quarry, where the chief product is building stone, may not contain over 40 per cent of lime. The remainder of the constituents will consist largely of magnesia and silica, both of which must be melted and run off as slag and are, therefore, of no use as a flux. You need just enough lime to unite with the sand on the pig iron and the ash of the coke, sufficient to form a fluid slag. Twenty pounds of a good limestone to each ton of iron melted will probably do this, but if not, increase the amount; frequently, as high as 40 pounds per ton are required. Lime and silica will not produce a fluid slag. Some alumina is required and this is taken from the ash or from the fire clay with which the cupola has been repaired, or from the brick lining. This reaction is indicative of the evil of using any more limestone than is necessary to make a fluid slag. Poor limestone, containing magnesia (dolomite), requires its own lime to flux its own silica and very little is left to act on the ash of the coke and the sand on the pig. It requires a large amount of heat to melt this or to produce a fluid slag. It is very poor economy to run 40 tons of iron through a 48-inch cupola in one heat, unless it is continuous melting, which would hardly be so in this instance. If you can keep the slag running, however, you can continue the heat as long as desired. As to the effect of limestone on the castings, it is liable to contain sulphur in the form of pyrites—blue streaks with bright yellow particles when the stone is wet—and such stone would ruin the castings. If the stone is free from sulphur, it will improve the castings, as it will cause the sulphur in the coke to pass off into the slag instead of into the iron. An excess of lime will destroy the lining of the cupola and increase the fuel consumption. It will also increase the amount of slag so that it is liable to chill around the tuyeres.

Aluminum Alloys

Question:—Will you kindly give me a formula for making aluminum crank case castings for motor cycles which weigh about 23 pounds each?

Answer:—Any one of the following formulas can be recommended: (1) Copper, 5 pounds. No. 1 aluminum ingot, 95 pounds. (2) No. 1 aluminum ingot, 76 pounds; copper, 2 pounds; zinc, 15 pounds; tin, 2 pounds. (3) Aluminum, 72 pounds; copper, 3 pounds; zinc, 25 pounds. (4) Scrap cast aluminum, 99 pounds; magnesium, 1 pound; zinc chloride, 1 ounce. Melt the aluminum, add the magnesium, throw the chloride on top and cautiously stir, pour at a dull red heat. Of these various alloys, No. 1 will be found the best, and the others in the order named.

The T. J. Peterson Co., Chicago, has opened a branch office at 512 Rockefeller building, Cleveland, in charge of George A. Burman. This concern manufactures core oils and other foundry specialties.

FOUNDRY and PATTERN SHOP EQUIPMENT

Exhibit of foundry supplies and equipment---Pneumatic rock-over molding machine---Sand mixing, rolling and blending machines

THE Chicago foundry trade was recently treated to a unique exhibit of foundry machinery and appliances by the S. Obermayer Co., Chicago. The exhibition was held in one of the Obermayer warehouses on Wednesday, Oct. 26. Although the doors of the exhibition room were only open for one day, the show attracted considerable attention and the attendance of foundrymen from various points in the Chicago district and throughout the middle west was large. Attendance was by request only, and over 2,000 invitations were issued to the trade. The materials exhibited included practically everything used in a foundry from a cupola down to the smallest chaplet. The display was well arranged and the visitors were given every facility for examining the various kinds of equipment. Henry E. Pridmore, molding machine manufacturer, Chicago, displayed a 22-inch by 18-inch rock-over drop molding machine and also two 10-inch stripping plate machines. All the molding machines were shown in actual operation and this feature of the show attracted considerable attention from the visitors.

During the noon hour the guests at the exhibition were treated to a dainty buffet luncheon through the courtesy of the S. Obermayer Co. It is estimated that over 500 foundrymen saw the exhibit during the course of the day, and the display was so successful that it is the intention of the S. Obermayer Co. to make it an annual affair. Following is a list of the principal exhibits:

Whiting Foundry Equipment Co.: One 30 x 48-inch spur geared tumbler; one 30 x 48-inch steel plate tumbler, spur geared; one drawer type core oven; one core oven car; one pig iron car; one overhead track with switch; one trolley and one Whiting cupola, 37 inches in diameter inside of lining.

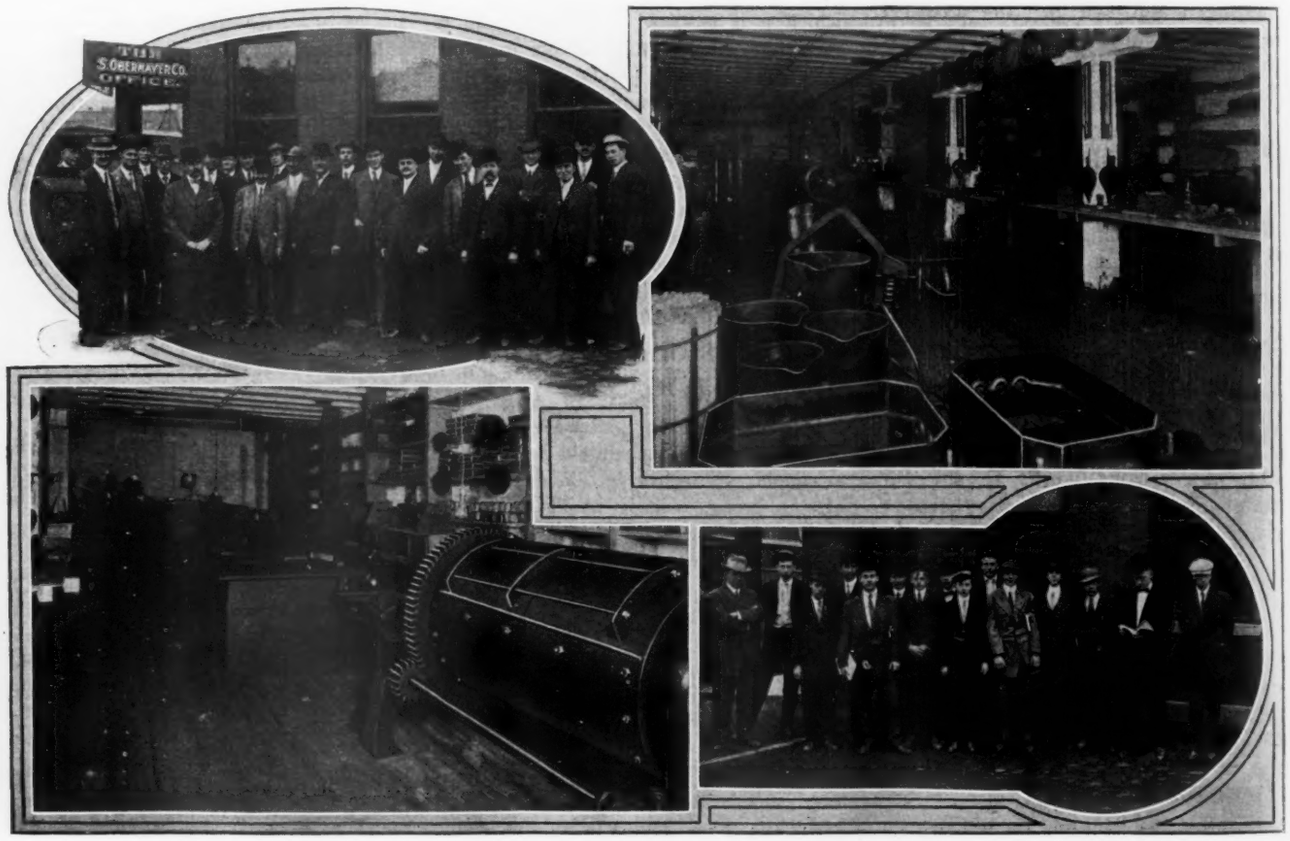
Walter MacLeod & Co.: One 18-inch sand blast machine; one heater and one heater burner for skin drying molds.

Dings Electro-Magnetic Separator Co.: One motor-driven separator.

Brown Specialty Machinery Co.: One No. 1 Hammer core machine.

Standard Sand & Machine Co.: One No. 2 batch mixer.

S. Obermayer Co.: One 48-inch plain top turntable; one 2-wheel coke barrow; one core wire straightener; one 30-inch Adams stationary molding press; one 30-inch Adams portable molding press; one Hanna electric screen shaker; one Hanna rotary revolving dumping riddle; four pit type brass furnaces; three Millet type core ovens; one Todd tumbler; one Obermayer sprue cutter, capacity up to 2 inches diameter, yellow brass; one



SOME OF THE FOUNDRYMEN WHO ATTENDED THE EXHIBIT OF FOUNDRY SUPPLIES AND EQUIPMENT, HELD BY THE S. OBERMAYER CO., AT ITS CHICAGO MANUFACTURING PLANT

GENERAL VIEW OF THE S. OBERMAYER CO.'S EXHIBIT

S. OBERMAYER CO.'S EXHIBIT OF HEAVY MACHINERY

C. E. HOYT AND CLASS IN FOUNDRY PRACTICE AT THE CHICAGO EXHIBIT OF THE S. OBERMAYER CO.

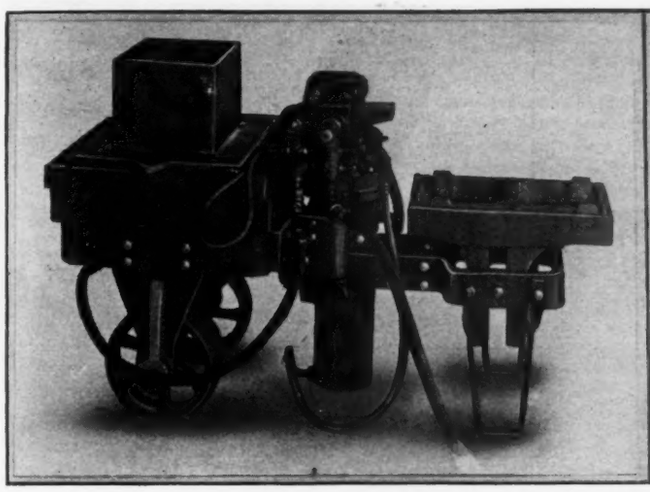


FIG. 1—PNEUMATIC ROCK-OVER MOLDING MACHINE, ON WHICH IS FITTED A PATTERN OF A HOPPER FOR GASOLINE ENGINE

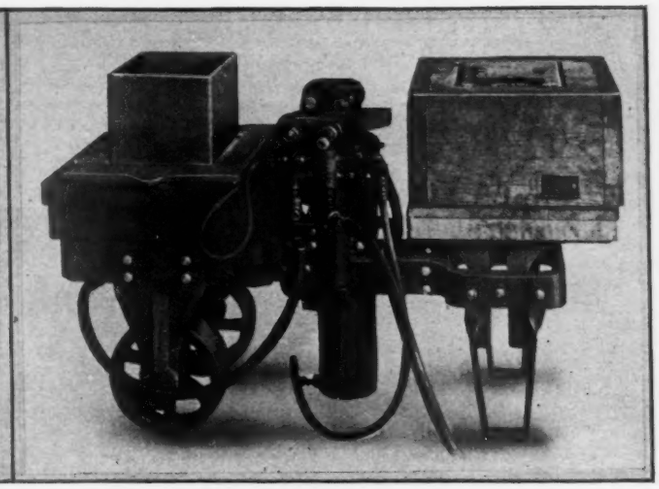


FIG. 2—MOLD RAMMED AND ROLLED OVER, THE PATTERN HAS BEEN ROCKED BACK IN POSITION FOR MAKING ANOTHER MOLD

rosin grinder; one coremaker's bench and ladles, crucibles, metal flasks, facings, chaplets, dowel pins, brushes, bellows, wind gages, etc.

Henry E. Pridmore: One 22 x 18-inch, rock-over drop molding machine and two 10-inch, round stand stripping plate machines.

Pneumatic Rock-over Molding Machine

A portable, rock-over molding machine which rams the mold and rolls over the pattern by compressed air, built by the E. Killing's Molding Machine Works, Davenport, Ia., is shown in the accompanying illustrations. Mounted on the jar-ramming table in Fig. 1, is a pattern of a hopper for gasoline engines, having very little draft and 10 inches deep. The pattern plate is attached to the rock-over table, which rests on the jar-ramming table of the machine. After the flask is adjusted and filled with sand, air is admitted to the cylinder underneath the jarring table and after ramming the mold the flask is clamped and rolled over, as shown in Fig. 3. This movement is likewise accomplished by compressed air, the cylinder being located directly underneath the shafts on which the rock-over arms rotate.

After rocking-over, the flask is delivered onto an equalizing frame which automatically adjusts itself to any inequalities in the bottom board. The equalizing frame is self-locking and requires no attention from the operator. It is also adjusted to the height of the flask and can be raised or lowered, as required. The drawing of the pattern is likewise accomplished by compressed air and by another cylinder than the one that rolls over the flask. The flask on the equalizer frame, and after drawing the pattern, is illustrated in Fig. 4. The pattern rolled back on the rock-over arms and resting on the jarring table ready for making another mold is shown in Fig. 2.

This machine is also adapted for making cores, as illustrated in Figs. 5 and 6. The core box before being filled with sand is shown mounted on the rock-over arms on the jar-ramming table in Fig. 5, and in Fig. 6

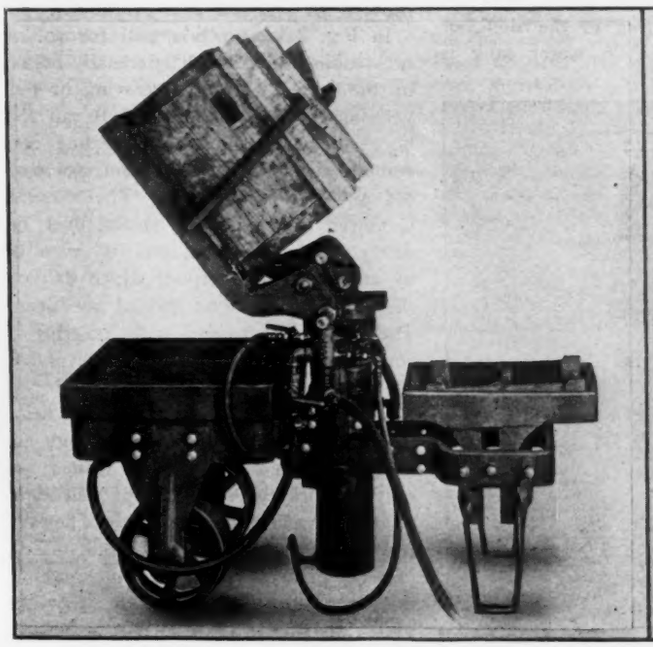


FIG. 3—ROLLING OVER THE FLASK

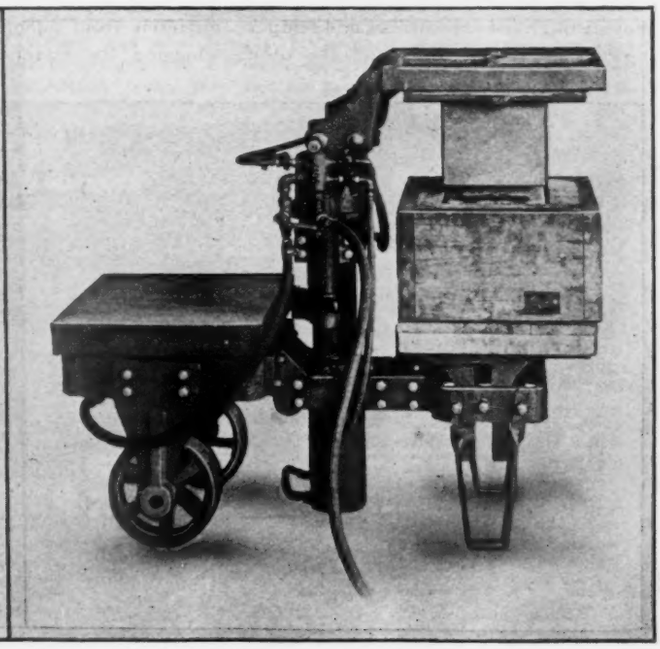


FIG. 4—DRAWING THE PATTERN

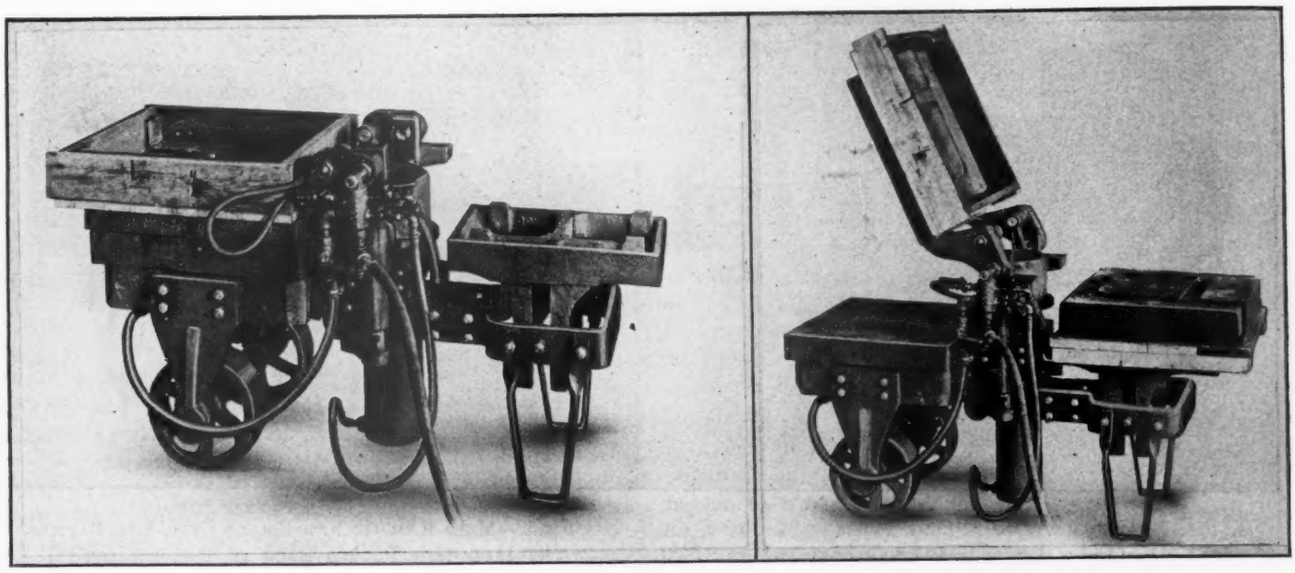


FIG. 5—CORE BOX MADE ON PNEUMATIC ROCK-OVER MOLDING MACHINE

FIG. 6—CORE BOX LIFTED AWAY FROM CORE

the core box has been lifted away from the core and is being rolled back into position for making another core.

The maximum draw of the machine is 10 inches and it has a capacity for rocking-over molds up to 250 pounds in weight. The weight of the machine is 600 pounds, air consumption 15 cubic feet of free air per minute and the height to the top of the jarring table is 22 inches.

Sand Mixing and Rolling Machines

The Standard Sand & Machine Co., Cleveland, manufacturer of sand-preparing equipment for iron, steel and brass foundries, has designed two new mills, the one intended for mixing and tempering core and facing sands and the other for rolling or blending core, facing, new and old sand.

Fig. 1 shows the mixing and tempering machine. In addition to preparing core and facing sand, it can be used for renewing old sand heaps and cleaning gangway sand. The materials to be mixed are fed into the end of the revolving screen, the tailings being discharged at the opposite end of the screen through a spout. After the sand passes through the screen, it discharges into a trough which contains a series of paddles in pairs, every alternate pair being set at right angles. These paddles are so arranged that the mixing is quickly accomplished by thoroughly cutting over and rubbing the materials together. Extending beyond the paddles are two adjustable steel scrapers, which eliminate the wear of the paddles and prevent the material from adhering to the shell, or clogging the mixer. A water tank is provided and delivers water, measured by a gage to a spray pipe which extends the full length of the mixer. In this way the sand is uniformly tempered and the amount of water discharged is under control of the operator. A spraying device is also provided for introducing oil or other core compounds into the sand, while it is being mixed. The oil can be heated by steam if desired. This facilitates the spraying of the oil in very fine streams into the sand and the amount of oil or binder to be introduced can be accurately measured, a gage being provided for this purpose. The mixture is automatically discharged through a gate in the bottom of the mixer, either into a box or wheelbarrow, as desired. The machine is built in three sizes for batch and continuous mixing. It has a capacity of 70 cubic feet per hour.

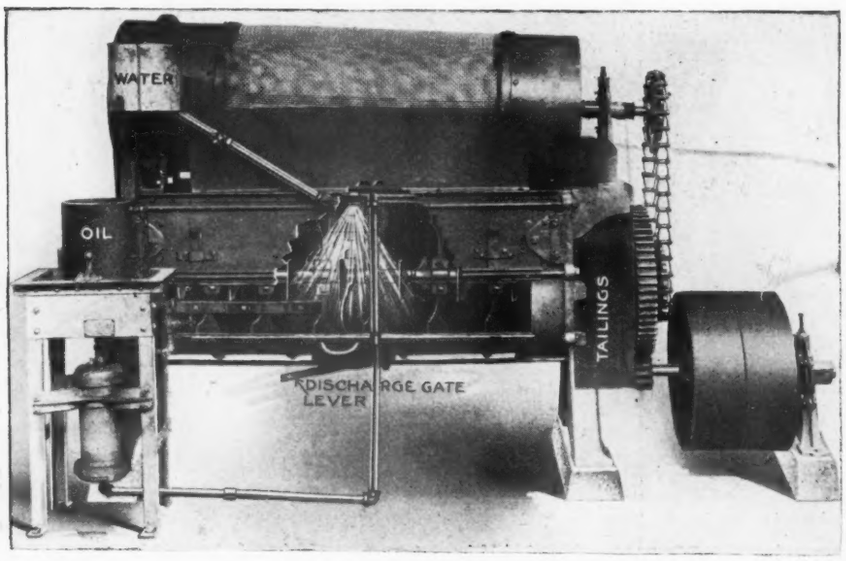


FIG. 1—SAND MIXING AND TEMPERING MACHINE

In Fig. 2 is shown a mill for rolling or blending sand which effectually breaks up the lumps without destroying or pulverizing the grains of sand. It can also be used for crushing and blending core compounds and for clay, resin, sea coal, old and new sands, etc. The material is placed in the hopper, shown over the drum of the machine, and is conveyed by an auger into a spout which delivers the material into one end of the drum. The drum is provided with a series of conveying buckets, and while revolving, these buckets carry up the sand and drop it upon the rolls. Before being discharged, the sand passes through the rolls eighteen times. This rolling not only crushes the small lumps, but thoroughly blends the material. The two rolls extend the length of the drum, the one being stationary, while the other is held in position by springs on either end of the shaft. As the sand passes through the rolls, the movable unit is forced back and the tension of the springs is

never sufficient to pulverize the grains of sand. Both machines are belt-driven and are constructed with a view of reducing the wear on working parts to the minimum.

Buffalo Foremen Organize

At a meeting of the foundry foremen and superintendents of Buffalo and vicinity, held in the room of the Buffalo Employers' Association, Buffalo, Wednesday, Oct. 26, preliminary arrangements were made for the organization of a local branch of the Associated Foundry Foremen. Robert B. Thomson, president of this society, presided, and in his opening remarks pointed out the educational advantages to be derived from an organization of this kind. W. M. Corse, secretary of the Brass Founders' Association, gave an account of the association work in Detroit and former President McQuillan, of the Associated Foundry Foremen, briefly outlined the work of the New York City branch. J. R. Battenfeldt, of the Berkshire Mfg. Co., Cleveland, attended the meeting and gave an interesting talk on foundry conditions in Europe. A committee was appointed to nominate officers and the organization of the local will be effected at the next meeting in November.

Trade Publications

GRAPHITE PRODUCTS.—The Joseph Dixon Crucible Co., Jersey City, N. J., has issued a 38-page catalog which illustrates and describes its line of graphite products suitable for railroad use, and gives many hints and suggestions that should prove valuable to the mechanical departments of railroads.

RECORDING THERMOMETERS. — The Bristol Co., Waterbury, Conn., describes its line of recording thermometers for working ranges of temperature between 90 and 500 degrees Fahr., in a bulletin recently issued. These thermometers are especially adapted for measuring temperatures of feed water for steam boilers, japanning ovens, liquids in pipes, etc.

AIR COMPRESSORS.—The Sullivan Machinery Co., Chicago, in several bulletins recently issued describes its extensive line of small air compressors, adapted for various kinds of service requiring compressed air in relatively small amounts. Air compressor accessories, including air receivers, water separators, unloading devices, air reheaters, etc., are also illustrated and described.

MOLD DRYER.—The Hanna Engineering Works, Chicago, is sending to the trade a 16-page catalog, illustrating and describing portable mold dryers. These are extensively used on large work and many illustrations are included, showing their use at the plant of the Allis-Chalmers Co., West Allis, Wis. The capacity of a single mold dryer is from 200 to 300 square feet of surface, and coke is used for fuel. The dryer is equipped with a fan, operated by a motor, which forces the heated air through pipes into the mold.

HEATING FURNACES.—C. W. Scott, consulting engineer, Davenport, Ia., in a 30-page, illustrated catalog, recently issued, describes an extensive line of equipment, comprising generators, positive pressure blowers, gas furnaces for heating, tempering, annealing, forging, brazing, etc., as well as bench torches, blowpipes, pyrometers, calorimeters and air compressors for producing higher pressures than can be attained with ordinary pressure blowers. The generator described produces gas from a mixture of air and gasoline in the proportions of 85 per cent air to 15 per cent gasoline, and the system combines in one receptacle a storage tank for gasoline and a carburetor, in which the vapor is combined with the air and so converted into a gas. The tank is buried in the ground and a governing device permits the gasoline to flow to the carburetor, where it is vaporized and mixed with a current of air from a blower, forming the gas, which is then carried to the point of consumption. The quantity of gas produced is governed by the amount consumed, so a steady supply is always available for use in the various types of furnaces made in connection therewith. Mr. Scott is an expert tool hardener, having served 23 years at this work and his furnaces embody the results of his experience. He has been in charge of the tool hardening and heat treating department of the Rock Island Arsenal for the past six years.

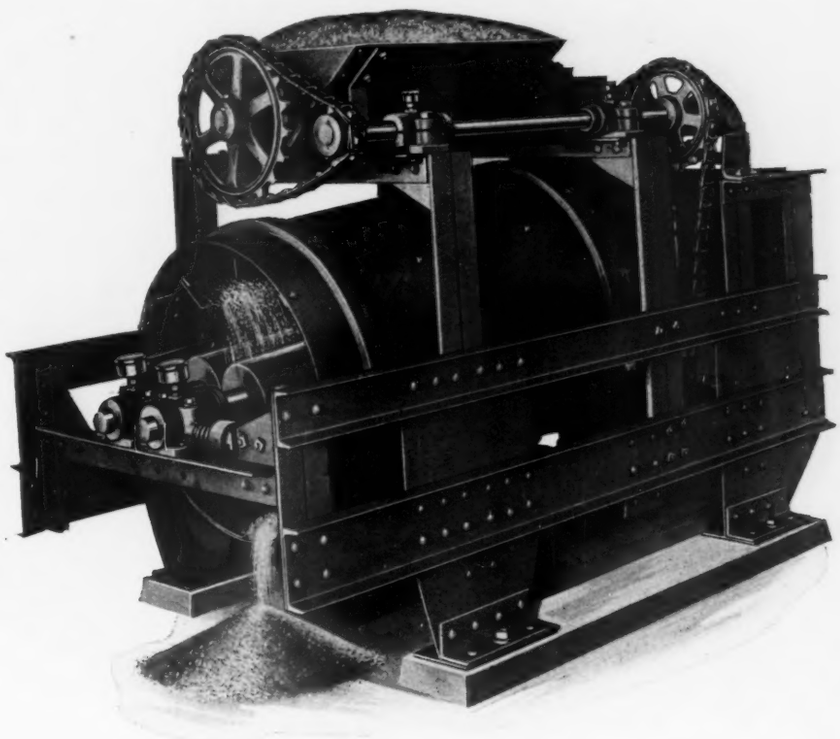


FIG. 2—MACHINE FOR ROLLING AND BLENDING SAND

General Industrial Notes

The Muskegon Steel Casting Co., Muskegon, Mich., has been incorporated with a capital stock of $30,000.

The University of Kansas has opened a new school foundry at Lawrence, Kan., in connection with the Fowler shops.

The O. S. Werntz Foundry & Machine Works Co., Warsaw, Ind., have been purchased by D. J. Dalton, of Chicago.

The Ohio Foundry Co., Dayton, O., has leased the plant of the Morris Foundry Co., Troy, O. J. W. Merkle is manager.

The Savill-Chandler Co., Canton, Ill., is building an addition to its foundry and machine shop, which will include a new core oven.

The Dempster Mill Mfg. Co., Beatrice, Neb., is erecting an extension to its foundry, 80 x 100 feet, one story high, of brick construction.

The Metal Extraction & Refining Co., Milwaukee, has been incorporated with a capital of $50,000. The incorporators are: W. J. Scanlan, W. A. Grieb and D. L. Grieb.

The Frontier Foundry Co., Los Angeles, Cal., has been incorporated with a capital stock of $25,000 by W. W. Walsh, B. D. Carle and A. Morganti.

The Croghan Foundry Co., Fremont, O., has been incorporated with a capital stock of $10,000, by Arthur Hetrick, W. A. Baker, C. H. Voss, Fred Voss and A. D. Collier.

The Hawkeye Foundry Co., Waterloo, Ia., has been incorporated with a capital of $75,000. The incorporators are: H. E. Headford, F. O. Hitchens, H. B. Plumb and W. E. Robinson.

The Oakley Steel Foundry Co., Millbury, Mass., has changed its name to the Millbury Steel Foundry Co. This concern makes crucible steel castings, vanadium steel and Monel metal castings.

The Sheffield Sash Weight & Mfg. Co., Kansas City, Mo., has been incorporated with a capital of $7,500. The incorporators are: Solomon Stoddard, George T. Cook and George P. Pierce.

The James Foundry Co., Clyde, O., manufacturer of car couplers, recently placed its plant in operation. The foundry is 60 x 80 feet, cleaning room, 25 x 32 feet, machine shop, 50 x 200 feet, and the power house, 16 feet square.

The General Foundry Co., Warren, O., will erect a plant for the production of converter steel castings. The officers of the company are, president, E. T. Ward; vice president, W. H. Hulme; secretary, J. E. Coulter, and treasurer, C. P. Kennedy.

The Brigham Brass Mfg. Co., Chicago, has been incorporated with a capital stock of $50,000 and will engage in the manufacture and sale of brass and bronze goods. The incorporators are: Silas H. Brigham and Milard S. Fegan, both of Waukegan, Ill.

The Hoey & Gallagher Foundry & Machine Co., Manor township, Armstrong county, Pa., has been incorporated with a capital stock of $50,000 to manufacture warm air furnaces, grates, radiators, etc. S. W. Gallagher, Manor township, Armstrong county, Pa., is treasurer.

The Kuebler Foundries, Inc., Easton, Pa., have been incorporated with a capital stock of $600,000, by William J. Kuebler, Col. Charles James and Thomas A. Malone, and have purchased the plant of the Sterlingworth Railway Supply Co., which they will operate and enlarge.

The Crescent Foundry Co., Rochester, N. Y., has been incorporated with a capital stock of $10,000 to manufacture iron and brass castings. The directors are: John A. Histed, Michael Frochler, Frank M. Erden, Max A. Hartung and John H. Zehlen, all of Rochester.

The Black Diamond Range Co., Newark, N. J., has been incorporated with a capital stock of $125,000 and will engage in the stove foundry business. The incorporators are: Alphonse Westee, Orange, N. J.; and Charles B. and Annabel Gurney, both of Newark, N. J.

The Dean Gas Engine & Foundry Co., and the Fox Reversible Gasoline Engine Co., Newport, Ky., have effected a consolidation. The new concern, which will manufacture gas engines, has been incorporated with a capital stock of $1,000,000 and will be known as the Dean Mfg. Co.

The Rensselear Valve Co., Troy, N. Y., has been recently incorporated to take over the business of the Rensselear Mfg. Co., of that city. The same officials will conduct the affairs of the new company that were at the head of the former concern, and no change in the business is contemplated.

The Arcade Mfg. Co., Freeport, Ill., has greatly increased the capacity of its brass foundry. Some changes have been made in the foundry equipment and a large number of molding machines have been added, which will enable this concern to make prompt shipments of all classes of brass and bronze castings.

The Allentown Foundry & Machine Co., Allentown, Pa., has been sold by Col. Henry C. Trexle and others, to Thos. Allen, of New York, and associates, who will use part of the plant as a works for insulating wire. The remainder of the plant will be operated as a general jobbing foundry by the A. M. Stocks Co., of New York.

The Parker & Topping Co., Brainerd, Minn., has been incorporated with a capital stock of $100,000 and will conduct a general jobbing foundry. The new concern succeeds Parker & Topping, who have operated a foundry at Brainerd a number of years. Charles A. Parker, Brainerd, is president; Herman W. Topping, vice president; and Clyde Parker, secretary and treasurer.

Lumby-Stenhouse, Ltd., Fort William, Ont., have commenced construction work on a new foundry and machine shop. The melting equipment will include a 12-ton cupola and a brass furnace, and it is expected that the plant will be ready for operation by the first of the year. This concern is a merger of the two firms of Lumby & Son and Stenhouse Bros., of Fort William.

The Harrisonville Pump & Foundry Co., Harrisonville, Mo., has been incorporated with a capital stock of $45,000. The company will make a specialty of the manufacture of gray iron and semi-steel castings for pumps and crusher parts. The officers are: N. P. Withington, St. Louis, president; Wallace H. Wright, Harrisonville, Mo., secretary; C. A. Fisher, Webb City, Mo., treasurer.

The Maryville Foundry Co., Maryville, Tenn., has been absorbed by the Furnace Equipment Co., recently incorporated. The new concern will add to the equipment of the shop and specialize the manufacture of a patented grate. The officers are: President, T. McNaughten; vice president and sales manager, D. E. McNaughten; secretary, treasurer and general manager, H. M. McNaughten.

Charles Bailey and Joseph A. Kelly, Pittsburg, who have purchased the plant of the Scaife Foundry & Machine Co., are making a number of improvements to the plant. While the new owners will continue to operate the foundry and machine shop along lines followed by the former owners, a 15-ton open-hearth furnace is being installed for the production of steel castings. This concern will be known as the Reliance Steel Casting Co.

New Construction.

The Rundle Mfg. Co., Milwaukee, Wis., is erecting an addition to its foundry.

The Hartsells Machine Co., Hartsells, Ala., is planning to erect a new foundry and machine shop.

The Malleable Iron Works, New Britain, Conn., will build an addition to its foundry, 40 x 80 feet.

The Canadian Westinghouse Co., Hamilton, Ont., intends to build an addition to its foundry that will cost $18,000.

The Kling Bros. Boiler Works, Chicago, will erect a machine shop and foundry, 160 x 250 feet, also a forge and power house, 60 x 80 feet.

The Union Foundry Co., Anniston, Ala., plans to enlarge its plant by the erection of an extension to the main foundry building, 120 feet in length.

The Excelsior Foundry & Machine Co., Columbia, Miss., has been incorporated with a capital stock of $20,000. The incorporators are C. B. Rice and W. B. Grand.

The Crosby Co., Buffalo, N. Y., manufacturer of sheet metal work, is erecting a one-story brick addition, 75 x 120 feet, to its foundry at Pratt and William streets.

The Connolly Steel Casting Co., Chelsea, Mass., has been incorporated with a capital of $5,000. The incorporators are James Connolly, John Ashman and Archibald Monroe.

The Marshall Furnace Co., Marshall, Mich., will erect a foundry, storage and an office building. The structures will be 154 x 124 feet, 40 x 50 feet, 140 x 160 feet and 36 x 50 feet, respectively.

The American Brake Shoe & Foundry Co., Mahwah, N. J., will erect and equip a plant at Chattanooga, Tenn., for the manufacture of crucible steel inserts for brake shoes. The building will be of brick, 80 x 150 feet.

The Seaboard Pipe Foundry, Savannah, Ga., contemplate the erection of a new plant and plans have been made providing for a foundry, 104 x 185 feet, machine shop and tapping room, 50 x 100 feet, and a cleaning room, 35 x 100 feet.

The Imperial Iron Works, Duluth, Minn., have commenced work on the erection of a foundry, 60 x 120 feet, of steel construction. The new building will be located on the east side of the present machine shop on Fifty-second avenue.

The E. Killing's Molding Machine Works, Davenport, Ia., engaged in the manufacture of molding machines, is being extended by the erection of an addition to its foundry, 35 x 80 feet. All the necessary equipment has been purchased.

The Jackson Church Co., Saginaw, Mich., have decided to erect a new plant in Saginaw. This will consist of a pattern shop, foundry, machine shop, finishing shop and other buildings, including a power house. The plant will be equipped with electric motor drive throughout.

The Erie Engine Works, Erie, Pa., has placed its new gray iron foundry in operation. The building is 135 x 400 feet, and has been in course of construction since the first of the year. It is located on West Twelfth street and was completed under the personal direction of William Harding, president of the company.

The Dussalt Foundry Works, Lockport, N. Y., whose plant was recently damaged by fire, advises that its cupola room, fuel shed and a part of the main building, were destroyed. The buildings have been repaired and an addition, 55 x 65 feet, built to the foundry, with a new cupola room, 20 x 45 feet. A 10-ton, 30-foot span, traveling crane will be added, as well as a Whiting cupola, cinder mill, core ovens and storage sheds. A few molding machines will also be installed.

The Bunting Brass & Bronze Co., Alliance, O., would like to receive catalogs and prices, from manufacturers of foundry equipment, on flasks, melting furnaces, etc., for its new plant under erection at Toledo, O. Wood flasks with iron ends are required in sizes varying from 18 x 18 x 6 inches to 4 to 6 feet wide and 6 to 8 feet long, having cope and drag, 6 to 12 inches deep. Other equipment required include slip jackets, metal lockers, grinding wheels, flask weights, wheelbarrows, clamps for core boxes, standard core boxes, molders' benches, charcoal drying pans and grates for drying floor molds, crucible shanks, steel shelves for cores, shapers for tool room use, pit furnaces, motors and generators, milling machines, air compressors, ash crushers, blacksmith forge, wall crane with hand or electric hoist of 5-ton capacity, dust collector for polishing wheels, blowers for oil furnaces, oil melting brass furnaces, power sprue cutter, tumbling barrels, 2-ton chain blocks, sand blast outfit, magnetic separator, 1 and 2-ton geared ladles, molding machines, etc.

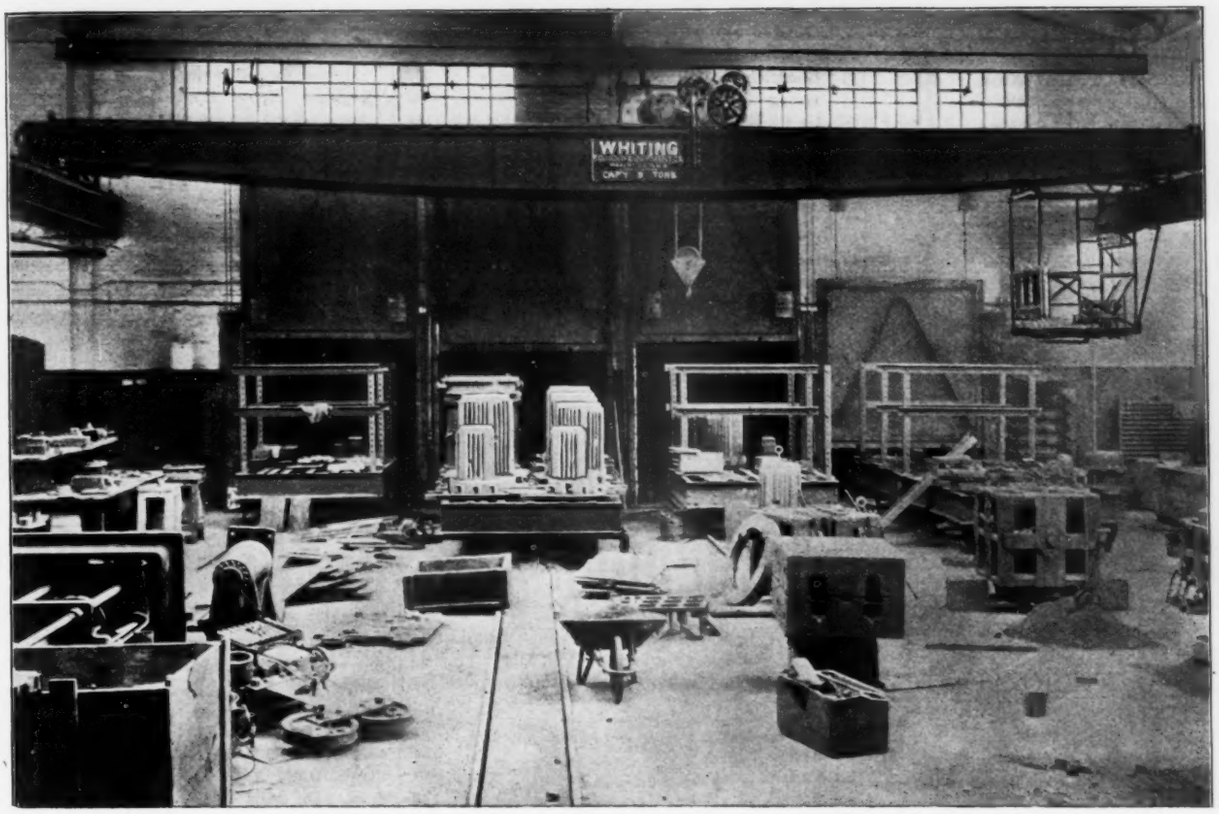
Among the Brass Founders.

The Ryder Brass Co., Bucyrus, O., has been incorporated with a capital stock of $10,000. The incorporators are: Parmly H. Ryder, Arnold Ryder, E. H. Ryder, A. S. Lenthold and S. Lenthold.

The Suspension Roller Bearing Co., Sandusky, O., has been incorporated with a capital stock of $250,000 and will erect a one-story brick building, 60 x 350 feet, part of which will be used as a brass foundry. The Osborn Engineering Co., Cleveland, have charge of the construction and equipment of the plant.

Whiting Electric Traveling Cranes

CRANES OF ALL TYPES FOR ALL PURPOSES



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Complete Equipment for Foundries

FOR ALL CLASSES OF CASTINGS:

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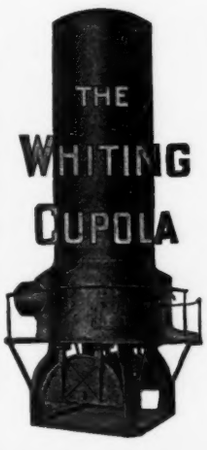

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